Sky and TELESCOPE

Coronagraph buildings at Climax

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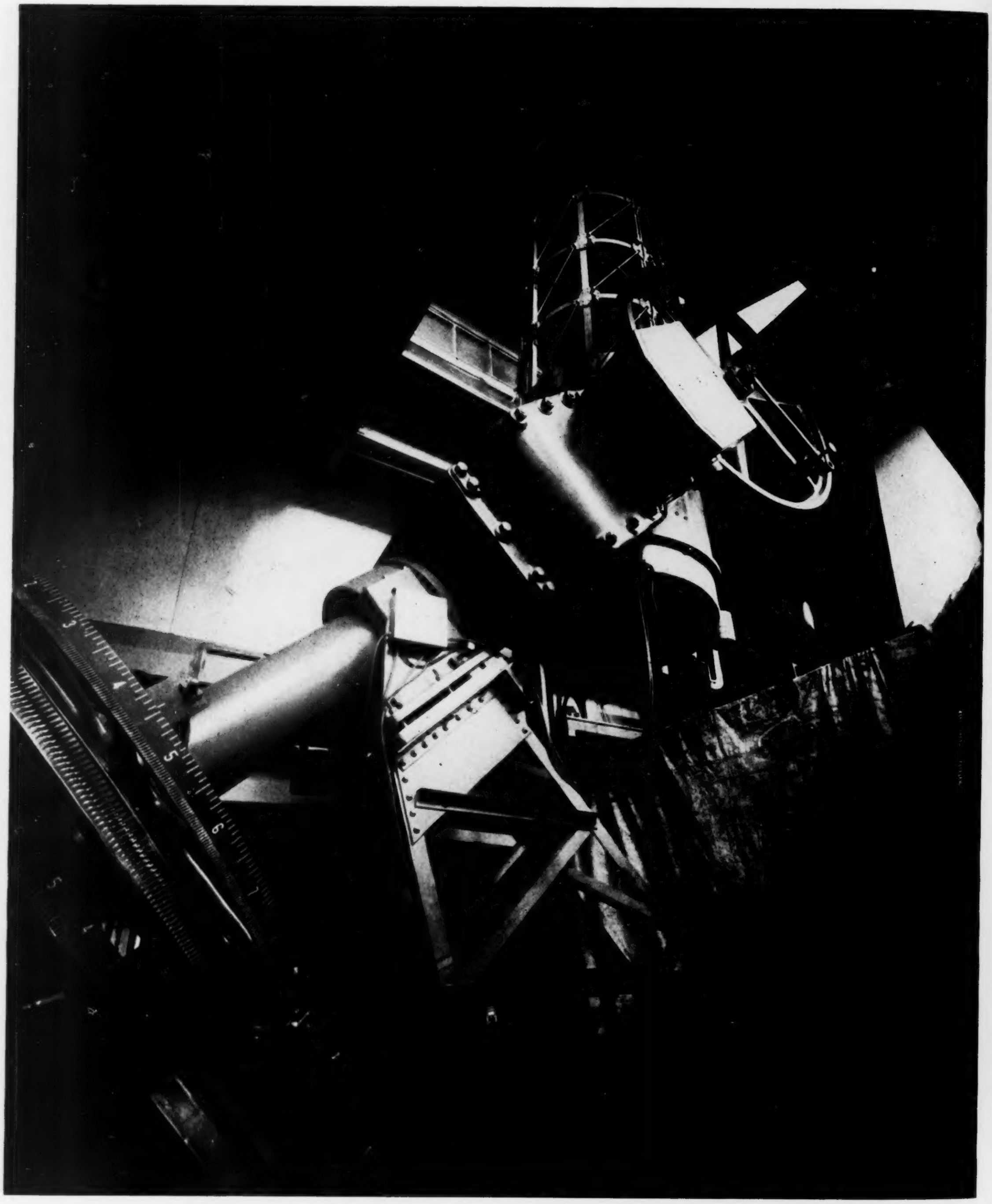

Sky and TELESCOPE

CHARLES A. FEDERER, JR., *Editor*
HELEN S. FEDERER, *Managing Editor*
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CURRENT OBSERVING PROGRAMS FOR MARS

AT THE BEGINNING of July, Mars will be within 40 million miles of the earth, closer than at any time since 1941. This is a long-awaited opportunity for a concerted observational attack upon the many puzzles presented by the red planet.

Last summer during the Boulder, Colorado, meeting of the American Astronomical Society, an informal group discussed what to do about Mars in 1954, and out of this developed the International Mars Committee, under the joint chairmanship of Drs. A. G. Wilson and E. C. Slipher, of the Lowell Observatory. At the Washington meeting of the committee on March 29th, Dr. Slipher reported on co-operative observing plans involving 17 observatories in 10 countries.

An important part of the program will be a continuous photographic record of the planet's surface in blue, yellow, and red light, from May 1st to September 15th. This work is being shared by large telescopes at eight observatories: Pic du Midi (France), Lamont-Hussey (South Africa), Helwan (Egypt), Kodaikanal (India), Bosscha (Java), Mt. Stromlo (Australia), Lowell (Arizona), and Eva Peron (Argentina). The preponderance of equatorial and Southern Hemisphere stations in this list is required by the fact that at many northern observatories Mars will be too low in the sky for favorable observing, while in South Africa, for example, the planet will pass through the zenith. The distribution of these stations in longitude should permit a practically round-the-clock patrol.

This survey should give valuable information about Martian clouds, seasonal changes in the dark markings, and the mysterious temporary clearing of the blue haze in the Martian atmosphere. Normally, photographs of Mars made in blue light show only atmospheric features, the dark surface markings being veiled and usually visible only in light of longer wave lengths. However, occasionally a planet-wide clearing of the atmosphere occurs, and for a few days the dark markings can be photographed in blue. If this still unexplained phenomenon recurs in 1954, it will be under a sharper scrutiny than ever before.

To make the photographs from all eight observatories readily intercomparable, the Mars committee has suggested particular photographic emulsions and filters to be used, and it has recommended photometric calibration of all plates. It has also urged that the exact time of each exposure be recorded, so that it can be used in studying the rotation period of Mars.

Many other observatories plan special programs. An important problem is the nature of the canals. The existence of these features is no longer seriously questioned, but there is growing evidence that the canals, and indeed the dark markings generally, are resolved into very complex fine detail by large telescopes in the very best seeing. As these fine details are too intricate to be drawn very satisfactorily, photographic records of them are planned. At Mount Wilson, Dr. E. Pettit will seek to utilize the moments of superseeing by motion-picture photography at the coude focus of the 100-inch reflector, following the plan he described in *Sky and Telescope*, November, 1953, page 27.

Photographs will be taken at the coude focus of the 200-inch Mount Palomar telescope by Dr. M. L. Humason. The 500-foot equivalent focal length of the coude arrangement will give images of Mars in the focal plane fully 5/8 inch in diameter. Also at

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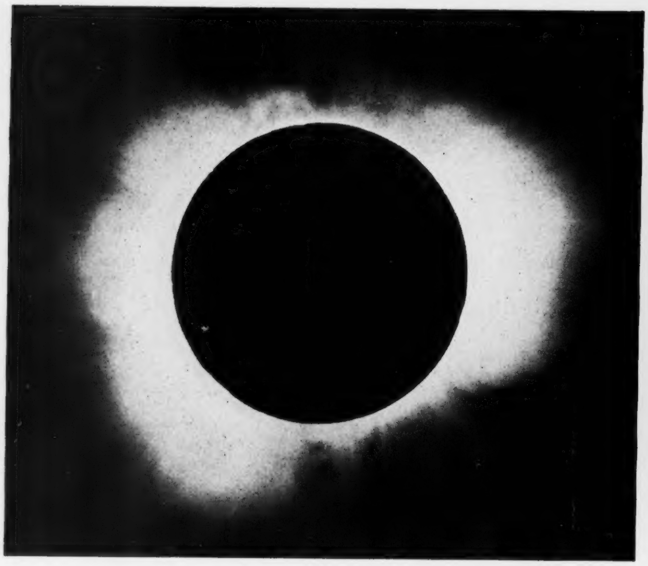
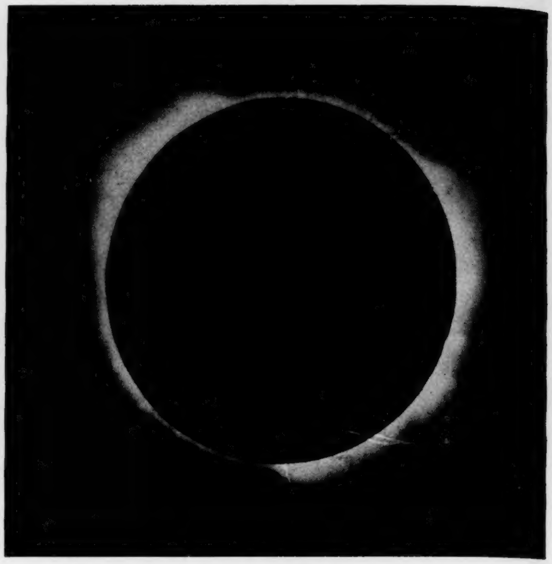




The characteristics of the white-light corona change during the sunspot cycle. Left: Edison Pettit's photograph of the June 8, 1918, eclipse shows the high-latitude coronal rays and streamers typical of sunspot maximum. Right: The eclipse of February 25, 1952, near the time of sunspot minimum, displayed coronal rays concentrated in equatorial regions, with a system of well-defined plumes over the poles. Yerkes Observatory and Naval Research Laboratory photographs.

The Formation of the Sun's Corona

By Donald E. Billings, *High Altitude Observatory*

"FROM immemorial antiquity," wrote C. A. Young, of Dartmouth, in 1872, "this magnificent spectacle has been well known and enthusiastically described; and it is beautiful and impressive exceedingly, almost beyond the conception of those who have not seen it for themselves."

In spite of the long history of naked-eye and telescopic studies of the luminous halo of the sun's corona as seen during an eclipse, the sum of man's knowledge concerning the solar atmosphere that had accumulated prior to 1868 was certainly much less than the information added during the four eventful years that followed.

Prior to 1868 there had been marked disagreement among astronomers as to whether the corona and prominences were solar, lunar, or terrestrial phenomena. A critical experiment proposed to answer this question was for two observers at widely separated points in the path of an eclipse to sketch the coronal streamers. If the sketches were the same, the corona would not be considered to originate in the earth's atmosphere. Alas! This test was doomed to failure, as it was found that two observers standing side by side usually sketched the features differently.

During the four years mentioned, the first event was a great eclipse in India in August, 1868, observed by a number of leading astronomers. Several were engaged in the study of light from the prominences by means of the spectroscope, the first undertaking of its kind in history. The experiment was a striking success. All who undertook it were rewarded by a glimpse of a brilliant emission-line spectrum. But after the few breathless minutes of totality had passed, the observers found they could not agree upon the exact positions in the spectrum of the lines they had seen.

However, one of the group, the French spectroscopist J. Janssen, was so impressed by the brightness of the red emission line in a prominence that he resolved to look for it after the eclipse. The next morning, with his spectroscope set on this red line, he successfully observed a prominence—the first such view ever obtained without the aid of an eclipse. (The same discovery was independently made a few days later by Norman Lockyer in England.) Thus relieved of the hurry associated with eclipse observations, Janssen was able in a few minutes to establish that the red line was due to hydrogen.

These discoveries had two important effects on study of the corona. They aroused the interest of the astronomical world in the importance of emission lines in the sun's atmosphere, and raised the hope that the corona, like prominences, might be observed without the aid of an eclipse.

Emission lines in the corona were soon to be discovered. Young was perhaps the first observer to establish that such lines existed. During a total eclipse in 1869 he observed a bright green line, accurately measured its wave length, and clearly determined that it originated in the solar corona. He also thought that he observed two much weaker lines. W. Harkness also recognized this green line as belonging to the corona, and made a fair determination of its wave length. Some others, including Lockyer, observed the line but could not determine its origin. It was not until the next year that Young's observations were confirmed and accepted by the scientific world.

Another achievement of the same period was the successful photographing of the corona in white light during several eclipses. By the comparison of such photographs, astronomers established the solar origin of the corona and the reality of its streamers.

The hope of observing the corona without an eclipse was phrased by Young: "Could the corona by some means be brought within the range of daily observation as the chromosphere has been, we might hope soon to come to a more perfect knowledge of its nature. Its light is so feeble that it is difficult to conceive the possibility of this, and yet who can say what science may not accomplish?"

This hope was to live for 58 years (and nearly die) before fulfillment. During those years the corona was studied intensively at eclipses. The

streamers were photographed and shown to have changing configurations related to sunspot activity. They were found to resemble sunlight in color, but to have a spectrum from which the absorption lines were partially eliminated. In addition to a background of continuous emission, coronal spectra showed many bright emission lines.

Since the development of the coronagraph in 1930 by B. Lyot, the distinguished French astronomer, much more information about the corona has been gathered. We know that its temperature is extremely high, its density very low, and that some relations exist between coronal line emission and solar activity. Yet we cannot but feel that the "more perfect knowledge of its nature" that has come from our daily observations would disappoint Professor Young. Much mystery remains as to the origin of the corona, the cause of its high temperatures, the apparently inexhaustible supply of matter that condenses from it to form downward-moving prominence knots, and its relation to many atmospheric phenomena on the earth.

By the 1920's a sufficient number of coronal drawings and photographs had been accumulated to enable H. Ludendorff to point out a significant relationship between the shape of the white-light corona and the part of the sunspot cycle in which the corona is observed. The accompanying drawing is a composite based on our study of eclipse sketches and photographs over a period of 60 years, and is guided by generalizations made by Ludendorff, C. W. Allen, K. O. Kiepenheuer, and others.

The left-hand hemisphere of the drawing represents a situation which might exist in a sunspot cycle at a time when spot activity is high. Typical rays of the form shown in the upper left have their lower-latitude edges at the latitude of the greatest number of sunspots. The upper-latitude edges are parallel to the polar plumes, and quiescent prominences are frequently found near the center of the base, with striations arching over them.

As a sunspot cycle progresses, the zone of maximum spot activity moves gradually toward the equator. We can imagine the low-latitude edges of the coronal rays moving along with it. Whether such motion actually occurs we cannot say, as the long rays have been observed only at eclipses. We do find, however, that when the sunspot zones have moved from the northern and southern hemispheres nearly to the equator and the sunspot activity has subsided (marking a minimum of activity in the 11-year cycle), the appearance of the corona, as shown by the right-hand side of the drawing, suggests that rays from the northern and southern hemispheres have merged to form a broad equatorial streamer. Thus the configuration of the white-light corona has been rather fully described, although it has not been explained.

Considerable progress has been made also in determining the composition of the corona. Ludendorff, W. Grotrian, and others in the years 1925-1930, showed that the energy of the white-light corona was distributed among the various wave lengths in the same proportions as light from the luminous surface or photosphere of the sun. This implies that we see the white-light corona in scattered photospheric light, as Young and others had suspected many years before.

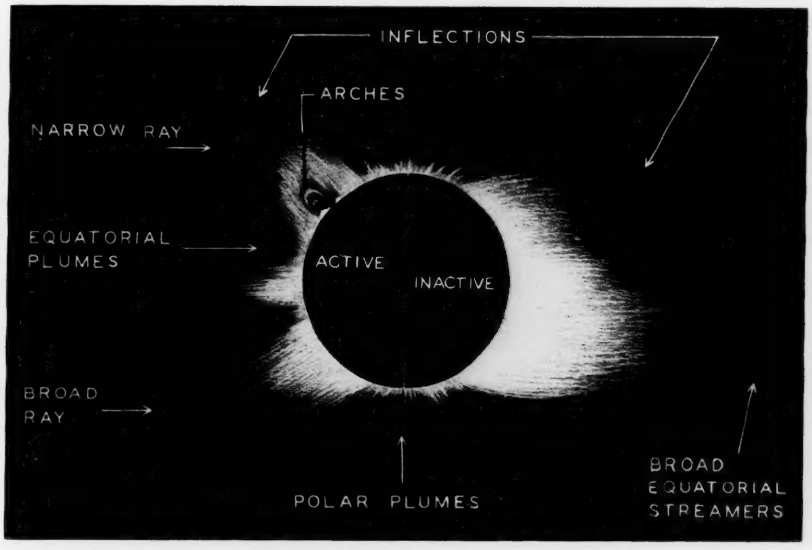
That Young was at a loss to suggest what gas could have such light-scattering properties is not surprising, since he considered the problem 30 years before the discovery of electrons. Only as recently as 1930 did the Dutch astronomer, M. Minnaert, suggest that electrons were responsible for a part of the corona's light. And only within the past 10 years have H. C. van de Hulst and Allen shown the white coronal light to be composed of two parts, one scattered by electrons in the solar atmosphere and the other by solid particles lying between the earth and the sun.

The appearance of the corona depends, to a large extent, upon the wave length of the light in which we observe it. Before 1870, it had been seen only in the white light consisting of all wave lengths that reach us from the sun. Young fully expected the corona seen at the wave length of the green emission line to surround the sun in the same configuration as the white-light corona. When, at a later eclipse, he observed the green-line corona in a slitless spectroscope, he was surprised to see that the two structures were entirely different. During subsequent eclipses, it was found that the green-line emission was most pronounced during periods of strong sunspot activity.

In recent years, observations of the coronal spectrum have been a daily routine at several coronagraphic stations, including the Pic du Midi Observatory in the Pyrenees Mountains, where Lyot established his first coronagraph. He observed the detailed coronal structure in the light of its emission lines, using a system of birefringent filters attached to his coronagraph. He found that the green-line emission shows dense concentrations over active sunspot centers, but little intensity elsewhere around the sun's limb.

M. Waldmeier, in Switzerland, and W. O. Roberts and his associates at the High Altitude Observatory have paid particular attention to these same areas of green-line emission that we call coronal regions or simply C-regions. We find them to extend 15 to 45 degrees in solar latitude, to appear shortly after the spot groups appear, and to persist for a few weeks after the spots disappear. A coronal region is usually brighter for one or two solar rotations (of 27 days each) following sunspot and flare activity in the spot group, and its sharp boundary frequently expands slowly outward.

The second brightest visible emission in the corona is the red line at 6374 angstroms. Like the green-line corona, the red-line concentrates near active centers, but its structure is somewhat



These are the principal features of the white-light corona seen at total solar eclipses. At the left, with high solar activity, there are rays in high latitudes, equatorial plumes generally found over sunspot regions, and arches over quiescent prominences. When solar activity is low, and no sunspot centers are near the limb, a broad equatorial streamer is seen; there are also polar plumes, whose appearance suggests the existence of a general solar magnetic field. High Altitude Observatory drawing.

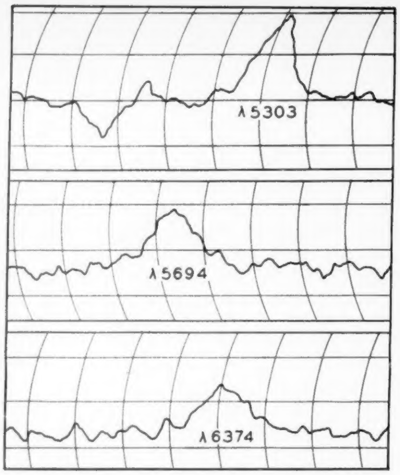
different. It has small, bright filaments near active centers and a widespread lower-intensity e m i s s i o n elsewhere. Strong red emission appears earlier than green emission following the outbreak of an active center and, in general, declines more quickly also.

A third coronal emission line that has been studied in some detail is the yellow line at 5694 angstroms, discovered with a coronagraph rather than at eclipses. Waldmeier noted that it appeared near centers of high activity, and on one occasion observed it to be brighter than the green line. We at the High Altitude Observatory have made a detailed study of it and have found it to be closely associated with limb flares and certain types of active prominences. The yellow-line corona never extends far above the sun's limb and is seen for only a short time near active centers.

We have described here not one but four coronas—coexistent but of entirely different structure. A detailed study of the corona in its 28 or more emission lines would be likely to reveal other and different structures. Any adequate theory of the corona must explain how these different structures are related. It must also show their relation to prominences, sunspots, and flares. The problem is not an easy one, as the many phenomena are very complex. Also, coronal regions can be observed only when they are on the limb, and then only when the sky is quite clear.

A large step in the problem's solution was made in 1938, by the Swedish astrophysicist, B. Edlén, who identified the green line as being due to the radiation of iron atoms (Fe XIV) that had lost 13 of their ring electrons, and the red line as coming from Fe X, from which nine of the outer electrons had been removed. The very high ionization of these and other coronal ions indicated exceedingly high temperatures for the corona, of the order of a million degrees.

The source of the yellow line had not been established until recently. In 1942, Edlén suggested that it was due



Tracings of the profiles of the green, yellow, and red lines in the spectrum of the solar corona. The vertical scales are intensity, the horizontal are wave lengths. Measurements of the widths of the three lines on these tracings helped High Altitude Observatory astronomers to identify the atom giving rise to the yellow line at 5694 angstroms.

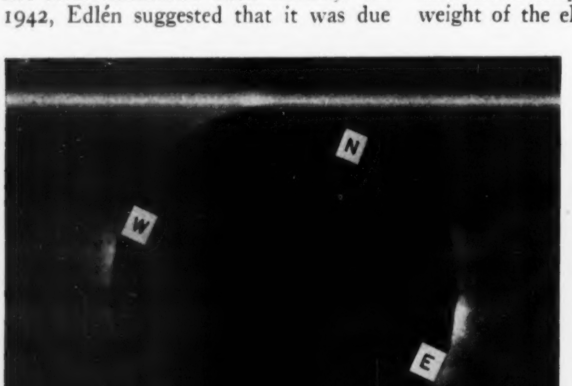
to Ca XV, calcium atoms that have each lost 14 electrons. But many astronomers doubted this identification, because a shorter wave length line of Ca XV, nearly equal in strength, should accompany the yellow line, and observations showed only a much weaker line near 5446 angstroms. The problem now appears solved by C. Pecker, Dr. Roberts, and the writer, who find Edlén was correct in his suggestion. The decisive evidence came from coronal spectra taken at our Climax observing station (see the front cover) on February 2, 1950, by W. N. Fleming. On that day the yellow line was more intense than any other we had observed in a decade.

On these spectrograms the widths of the yellow, green, and red lines could be measured. Each width depends on the kinetic temperature and the atomic weight of the element that gives rise to the line. The green and red lines were known to be due to iron. Therefore, assuming that the temperature was the same for all three lines, the ratios of the line widths should give the atomic weight of the element responsible for the yellow line. This atomic weight comes out 40 ± 2, pointing strongly to calcium.

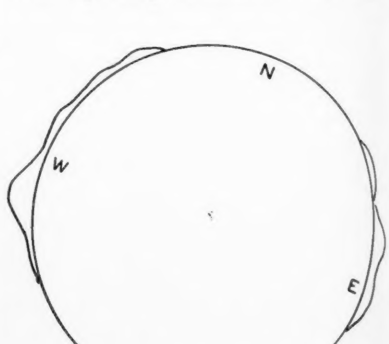
But why should the other line, at 5446 angstroms, be so weak? Like the other coronal lines, this is an emission line, observed against a bright continuous background of scattered light from the sun's surface or photosphere. We noticed that there are two strong photospheric absorption lines very near this wave length. Therefore, most of the light of the coronal 5446 line simply goes to fill the gap in the continuous background, making the line appear much fainter than it actually is. When this effect was allowed for, the 5446 line had just the intensity that it should have if it, like the 5694 line, was due to Ca XV.

These results indicate that the temperature of the corona at times of great activity is even higher than had been previously believed. This is because the ionization potential of Ca XV is 841 electron volts, considerably more than the 233 volts of Fe X and the 355 volts of Fe XIV. We have also made recent studies of coronal line widths indicating that in quiet regions of the corona the temperature is about 2.3 million degrees, and that it may reach seven million degrees in active coronal regions.

During the past several years, in watching the day-by-day changes in the corona and the solar disk, Roberts and his co-workers have evolved a working hypothesis that ties many of the phenomena together. A concise formulation was made during the summer of 1953 by Roberts, Raymond Grenchik, of Indiana University, Donald Liebenberg, of the University of Wisconsin, and the writer. While spending the summer at the High



The green-line corona at the February, 1952, eclipse, photographed with a slitless spectrograph by the High Altitude Observatory's expedition to Khartoum. As the picture was taken a few seconds after the east limb of the sun was covered by the moon, features on that side are accentuated compared to those on the west limb. Bright streaks crossing the picture arise from the continuous spectrum of the corona.



Eight hours after the time of the eclipse picture to the left, the green-line corona was observed by the coronagraph at Climax, Colo. The distance of the curve from the circle is proportional to the intensity of the green line in that direction on the sun's limb.

Altitude Observatory, Mr. Grenchik attacked the problem of the white-light corona, and Mr. Liebenberg made a quantitative study of the emission corona from Climax and Sacramento Peak observations.

Our very speculative interpretation of the formation of the corona assumes a pattern of magnetic fields extending outward from each active center into regions comparable in extent to the coronal regions. This assumption is compatible with recent measurements by H. W. Babcock, at Mount Wilson Observatory, that show extensive magnetic fields in the photosphere near sunspot groups, and is substantiated by Miss R. Payne-Scott and A. G. Little's measurements of the polarization of radio noise coming from the corona.

These magnetic fields interact with each other and with the general dipole magnetic field of the sun to form "umbrellas" of magnetic lines of force over certain portions of the sun. Ions are ejected from the solar surface in spicules and from active centers, and drift along these lines of force in the direction of the weaker field, congregating at the top of the "umbrella." Ultimately the concentration of ions is sufficiently great that (since they are diamagnetic) they annul the magnetic field and an opening is provided through which the coronal rays pass as jets of protons and electrons streaming out into interplanetary space. Such coronal rays may, upon striking the earth, give rise to M-region magnetic storms. This hypothesis places the M-regions on the sun at positions well removed from active centers.

We explain the high-intensity filaments of the red-line corona as high-density regions, rendered so by material issuing from the active centers into the corona at times of solar flare activity. As the gas spreads out slowly from the active centers, along magnetic lines of force, its temperature rises slowly. This rise, indicated by a gradual increase in the ratio of green-line to red-line emission, may be the result of the transformation of the kinetic energy of fast-moving gas clouds into thermal energy. We interpret our failure to observe the return of the temperature to normal as due to the outward spread of the material, which has become too tenuous to observe before the temperature drops again. The spreading material, we postulate, replenishes the entire corona in the course of a few weeks.

In this regard, our concept of an expanding corona resembles one formulated by the Australians, J. H. Piddington and L. W. Davies, to explain solar radio noise observations.

Our theory of the corona makes no mention of prominences, although there are many aspects of prominence motion that are related to the corona. In fact, the long, arched trajectories of prominence material found near active centers first suggested to us the pattern of active-region magnetic fields which we have postulated. The quiescent prominences at the bases of the coronal rays may be coronal material, accumulated at the top of the "umbrella" of magnetic lines, that has acquired sufficient density to cool by radiation and has condensed further to become a luminous prominence.

This highly speculative hypothesis is based on very sketchy and scattered evidence. Worst of all, it deals with such complicated processes that we have not yet been able to make any quantitative tests of its plausibility. Nevertheless it does, in broad outline, explain many major phenomena of the solar atmosphere, and it may lead other astronomers to develop more nearly adequate theories of the formation of the corona and prominences.

This view from the southwest (in March, 1954) shows the 50-foot dome and building for the 16-inch coronagraph now under construction at the High Altitude Observatory. The same dome shows at the left in the front cover picture. The upper floor of the spectrograph wing will contain a long-focus optical system for a high-dispersion spectrograph. On the lower floor are darkrooms, laboratories, and other working space. High Altitude Observatory photograph.

CURRENT OBSERVING PROGRAMS FOR MARS

(Continued from page 251)

the 200-inch, Dr. John Strong and William Sinton, of Johns Hopkins University, will make temperature measurements on selected Martian regions with a sensitive radiometer. This may give information about topographic relief on Mars, as the temperature of tablelands should be lower than in neighboring depressions.

Besides photography, the program planned by the Lick Observatory calls for micrometer measurements of the satellites with the 36-inch refractor. Such measurements are useful for determining the mass and oblateness of Mars. Moreover, the progressive acceleration in the motion of the inner satellite, Phobos, is one of the outstanding problems of the mechanics of the solar system.

Spectroscopic studies are planned at the Yerkes and McDonald Observatories by Dr. G. P. Kuiper, who is also interested in visual color studies and in polarization measurements. Investigations of polarization are part of the program of the Pic du Midi Observatory in the French Pyrenees.

Measuring the size of Mars more exactly will be an aim of Dr. Slipher, who has gone to South Africa on a joint National Geographic-Lowell Observatory expedition. Early in April, he began his nine-month observing program with the 27-inch refractor of the Lamont-Hussey Observatory at Bloemfontein, Orange Free State.

At the Lowell Observatory, Drs. H. L. Johnson and Robert Hardie will measure the diameter of Mars by a photoelectric drift method. Information about systematic errors in diameter measurements will be sought in model experiments by Dr. D. Alter and P. Roques at the Griffith Observatory.

The brightness of Mars will be the theme of several investigations. How its brightness changes with phase will be determined photoelectrically at the Lowell Observatory by Dr. V. M. Slipher, and at Mt. Stromlo, Dr. R. v.d.R. Woolley will measure the reflecting power of the Martian surface.

This is far from a complete listing of studies that will be under way this summer, for other visual and photographic projects are known to be planned in several countries at regular observatories.

J. A.

Spectra of Visual Double Stars--I

By Otto Struve, *Leuschner Observatory, University of California*

THE fundamental work on the spectra of visual double stars was carried out in 1923 by F. C. Leonard at the Lick Observatory. His principal conclusions may be summarized in the form in which he gave them in a recent issue (January-February, 1954) of the *Journal* of the Royal Astronomical Society of Canada:

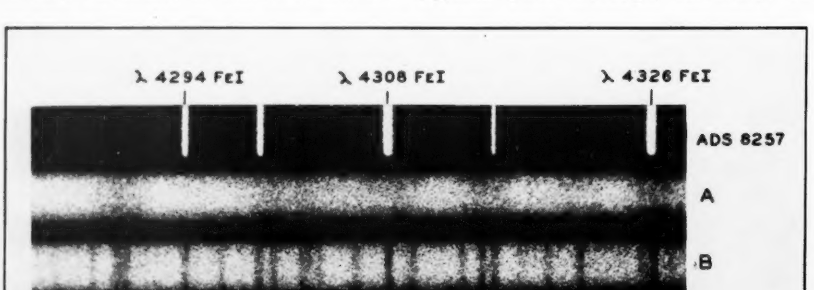
1. If either component of a visual binary is a main-sequence star, the spectral class of that component is generally the same as the spectral class of a single, main-sequence star of the same absolute magnitude; hence, if both components are main-sequence stars, the spectral class of the secondary is normally *later* than that of the primary, the difference in spectral class between the components being greater, the greater their difference in absolute magnitude.

2. If both components are giants, the spectral class of the secondary is almost always *earlier* than that of the primary, the difference in spectral class between the components being, with few exceptions, greater, the greater their difference in absolute magnitude.

3. If the primary is a giant or a supergiant and the secondary is a main-sequence star, the spectral class of the primary may be anything from class B to class M, that of the secondary being whatever is normal for its absolute magnitude; in this case also, the spectral class of the secondary is usually *earlier* than that of the primary; moreover, if the spectral class of the primary is earlier than class G, the difference in spectral class between the components is commonly small.

There is some observational evidence that, if any disparity exists between the spectra of the components of visual binaries on the one hand, and the spectra of single stars of the same absolute magnitudes on the other, the difference in spectral class between the components, particularly if they both belong to the main-sequence, is somewhat *less* than that between single, unrelated stars of the same absolute magnitudes; in other words, the components are more nearly alike spectrally than are single stars of the same intrinsic luminosities. If the components are of coeval origin, this conclusion is, perhaps, what might naturally be expected on *a priori* grounds.

Since 1950, approximately 40 visual double stars have been observed by the writer with the coude spectrograph attached to the 100-inch telescope of the Mount Wilson Observatory. Most of these systems were chosen on or near the main sequence of the Hertzsprung-Russell diagram. Systems containing giants, supergiants, or white dwarfs were excluded. Probably all of the systems are physical pairs although, for many of them, the separation is so large that no orbital motion has been detected. However, all of them have common proper motions and most of them are known to have compatible radial velocities. The range of spectral type included in this investigation is between *A*0 and *K*0. The main results of the work may be summed up as follows:



In the star ADS 8257 (No. 8257 in Aitken's double star catalogue), the brighter component, A, shows broad lines characteristic of rapid axial rotation, while the sharper lines of the companion's spectrum give little evidence of rotation. Below, the two members of ADS 8406 show a like effect, to a lesser degree. These spectra were obtained by the author at Mount Wilson; their dispersion is 10 angstroms per millimeter. The reproductions were made by K. Franklin, Berkeley Astronomical Department, University of California.

Relative Brightnesses and Spectral Types

1. When the magnitudes of the components are the same, their spectral types are also the same.

2. In all but one system (ADS 5166 =20 Geminorum), the brighter component is always the bluer or, at most, of the same spectral type as the fainter component.

3. In the one exceptional case (20 Geminorum), the primary has a later spectral type than the secondary and is 0.1 magnitude redder. At the same time, the primary is 0.65 magnitude brighter than the secondary. These photometric results are from the independent measurements made by G. E. Kron at the Lick Observatory and by D. Harris, III, at the McDonald Observatory.

4. From inspection of the H-R diagram for single stars, the slope of the main sequence between *A*0 and *K*0 is about two magnitudes per whole spectral class. Thus we would expect, for binaries, a difference of 0.4 in visual magnitude to correspond to approximately 0.2 spectral class. However, the observed difference in spectral type is almost never greater, and is often much smaller, than 0.2 when the two components differ by more than about half a magnitude. In other words, the spectra of the two stars tend to be more alike than would be consistent with the main sequence. Consequently, the slope of the line joining the two components in the H-R diagram is steeper than the slope of the main sequence for single stars.

5. The effect just mentioned is commonest among systems in which the redder component is of spectral type *F*5 or earlier. It is rare when both components are later than *F*5. Among the latest spectral types showing this effect is Zeta Herculis, for which the primary is a subgiant *G* star and the secondary a main-sequence *K*0 star.

Relative Rotations and Spectral Types

1. When the magnitudes of the components are the same, the axial rotations, as shown by the widening of the spectral lines, are almost always similar.

2. Almost without exception, whenever the difference in spectral types is abnormally small, the difference in the

rotational velocities of the components is large: The bluer and hence more luminous component is rotating more rapidly.

3. In the one exceptional case of 20 Geminorum described above, the primary star has sharp lines indicating small rotation, while the bluer secondary has a larger amount of rotation.

Some Examples

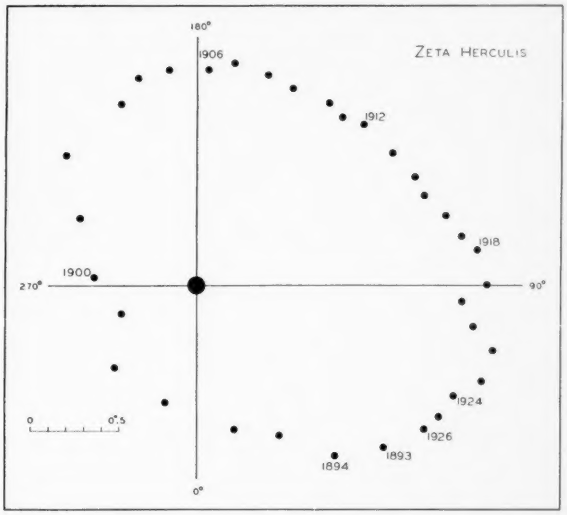
The accompanying spectra illustrate the tendencies described. In the case of ADS 8406 the difference in the magnitudes is about 1.6. The primary is *A*8, the secondary *F*2; hence the observed difference of the spectral types would correspond to a difference of 1.0 magnitude if both components were on the main sequence. Assuming that the fainter star is on the main sequence, the brighter star is about half a magnitude above it. The spectra of ADS 8406 show that the brighter component has diffuse lines and is, therefore, rotating rapidly while the fainter component has little or no rotation.

An even more extreme case is ADS 8257. Here the primary is of magnitude 7.0, the secondary 8.0. Yet the spectral types are both *F*5. We notice that the brighter star has excessively diffuse lines, its rotational velocity corresponding to perhaps 100 kilometers per second. The fainter component has only a small amount of rotation.

We could list a number of other systems illustrating the same tendencies. It should, however, not be thought that these departures from the main sequence are always present, for there are many double stars in which the two components agree reasonably well with the slope of the main sequence.

It is quite clear that these observational results spell out the same story that H. L. Johnson gave in the May, 1953, *Astrophysical Journal*, and which is discussed on page 8 of last November's *Sky and Telescope*. In this he demonstrated the inconsistency between the main sequence and the differences of the photoelectric colors of the components of a number of visual binary stars. There are very few systems common to the spectrographic work and to Johnson's program. Hence, we are concerned with a general tendency among the double stars to depart appreciably from the main sequence with regard to the slope of the line in the H-R diagram joining the components.

The most famous case is that of Zeta Herculis. For this system, the visual orbit is accurately determined, and we have a reliable knowledge of the distance to the system. The semimajor axis is 1.369 seconds of arc, and the parallax is almost exactly 0.100 second of arc; hence the semimajor axis in astronomical units is very nearly 14. The period of the system is 34.38 years. Consequently, the total mass according to the third law of Kepler is $14^3/34.38^2$ or 2.3 times the mass of the sun. A more exact computation by Glenn Hall recently gave 2.0 times the mass of the sun. Because of remaining uncertainties in the parallax and semimajor axis determinations, these two results indicate the degree of precision with which the total mass is known.



The orbital motion of the visual binary Zeta Herculis is indicated by the observed positions of the companion (with reference to the primary star at the center of coordinates) at roughly yearly intervals from 1893 to 1926. At present the companion is near the position it had in 1920. North is below, as in an inverting telescope.

The mass ratio of the system has also been determined by Hall from direct photographs made with the Yerkes 40-inch refractor. It is based upon measurements of the blended image of the two components with reference to distant stars in the same field. Although the blending introduces complications, these can be allowed for, and the best that can now be done is to accept Hall's result of 0.4 for the ratio of the mass of the fainter component to the total mass of the system. Using Hall's value of 2.0 for the combined mass, this would give, for Zeta Herculis A, 1.2 solar masses and for the secondary a mass 0.8 times the sun's.*

The latter quantity agrees well with the expected mass of a *K*0 main-sequence star, and with the classical mass-luminosity relation, although the mass of the secondary is somewhat too small for its luminosity. Even if Hall's mass ratio is not used, the other evidence would point to a mass of the brighter component between 1.2 and 1.4, again somewhat too small for the star's luminosity.

All we are here concerned with is the fact that Zeta Herculis A is a subgiant star that departs only slightly from the mass-luminosity relation and in no way resembles the lighter components of the Algol-type eclipsing binaries, which may have large departures, as mentioned on page 9 of our November article. Here is another confirmation that among the subgiants there are stars very different in physical character.

In our discussion next month, we shall consider some interpretations of these facts, in the light of several other recent astronomical results that undoubtedly represent further aspects of the same phenomenon.

(To be continued)

*P. van de Kamp has derived new masses for Zeta Herculis. The one of the brighter component is even a little smaller than that used here. He has also obtained new and exciting results on the masses of other double stars. But this work is as yet unpublished.

NEW ULTRAVIOLET CAMERA

A new monochromator-type camera for ultraviolet photography, using reflecting surfaces instead of quartz or lithium-fluoride optics that transmit short wave lengths, has been designed at the University of Colorado under contract with the Air Force Cambridge Research Center. Its particular application will be a study of solar limb-darkening in Lyman-alpha light at 1216 angstroms. The observations will be carried out from rockets, for below an altitude of 80 kilometers very little of this short-wave radiation penetrates our atmosphere.

In one of the three forms of the camera, described by W. E. Behring and his associates in the *Journal* of the Optical Society of America, March, 1954, sunlight falls obliquely on a concave spherical grating, passes through a slit at its focus, and encounters a second, identical grating which forms the image. The gratings are placed so that their dispersions neutralize each other.

The wave length varies across the field, having a range of 150 angstroms in one camera of somewhat different design, with which the sun has been successfully photographed in light centered near 4130 angstroms (the G band). Such pictures show a typical solar image with sunspots, but are crossed by a section of the Fraunhofer spectrum.

The Story of Cosmic Rays--V

By W. F. G. Swann, *Director*
Bartol Research Foundation, Franklin Institute

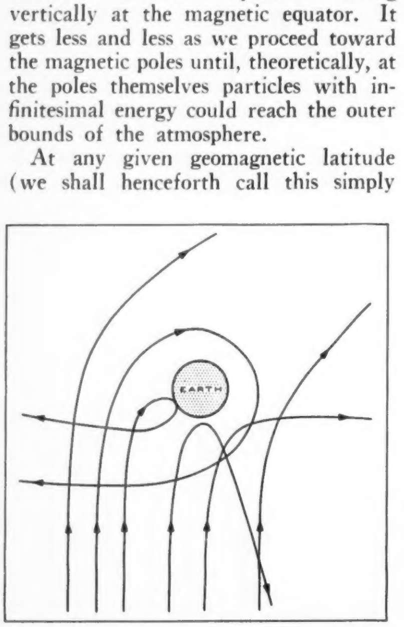
5. The Effect of Terrestrial, Solar, and Galactic Magnetic Fields

THE PRIMARY cosmic rays appear to come toward our earth uniformly from all directions, or nearly so. The earth is a huge magnet, with a magnetic field of small intensity but large extent, so that the paths of charged particles approaching the earth are bent. Consideration of the influence of the magnetic field leads to the following conclusion: Particles of the same charge and momentum (relativistic mass times velocity) are indistinguishable as regards the effect of the magnetic field upon them.

While the student of cosmic rays usually speaks of particles in terms of their momenta, the kinetic energy is a quantity more familiar to the layman. It is, however, less simply related to the bending effect in a magnetic field. Thus, for a given energy, heavy particles are bent less in their paths than are light particles.

Any charged particle, such as a proton, has to have a certain minimum energy before it can reach the earth's vicinity at all without being bent back into space by the magnetic field. That minimum energy amounts to 14 billion electron volts for a proton entering vertically at the magnetic equator. It gets less and less as we proceed toward the magnetic poles until, theoretically, at the poles themselves particles with infinitesimal energy could reach the outer bounds of the atmosphere.

At any given geomagnetic latitude (we shall henceforth call this simply *latitude*), the minimum energy for entry of positive particles into the atmosphere varies as the direction of entry varies. It is greatest for the east and least for the west, the value for the vertical being intermediate in amount.

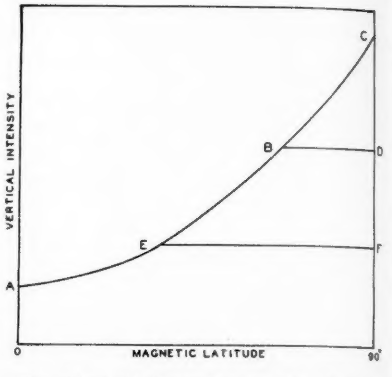


Paths of primary cosmic rays (in this case protons with 15 billion electron volts energy) as they are deflected by the earth's magnetic field. The paths are drawn in the plane of the earth's magnetic equator, with the north pole upward from the paper.

There was a time when a strong belief existed that the primary particles were photons and not charged particles at all. J. C. Clay's discovery of the variation of cosmic ray intensity with latitude, a discovery confirmed by a series of worldwide measurements by A. H. Compton and his associates, first led to the conclusion that there were at least some charged particles in the primary radiation. Later, as the matter was more deeply studied in connection with intensities from different directions, it appeared that there was no room for anything else but charged particles and, further, that the particles were positively charged.

Of course, the latitude effect is greatly complicated by the fact that our observations are made in the atmosphere itself. Suppose that observations could be made at an altitude so high that a negligible amount of air existed above. Then we might expect that the intensity of the radiation would mount continually as we passed from the magnetic equator to the magnetic pole and included in our measurements more and more of the less energetic radiation that can reach the atmosphere at higher latitudes. But if we should observe at a depth in the atmosphere, and even if we could be sure that we were measuring only the primary cosmic rays, we should expect that the increase of intensity with latitude would continue only until a latitude was reached at which the low-energy rays, deflected away by the magnetic field below that latitude, would still be unable to reach us because they were stopped by the atmosphere.

From this viewpoint the variation with latitude of, let us say, the vertical intensity of the primary cosmic rays might take the form shown in the accompanying simple diagram. The curve *ABC* would hold at very high altitudes; *ABD* would apply at a place where there is an appreciable amount of the atmosphere above; *AEF*, where there is more of the atmosphere above, and so on. We might thus expect that the knee of the latitude curve—the place where the horizontal portion starts—would occur at a latitude which was greater the greater the altitude.



The effect of absorption by the atmosphere on the intensity of cosmic rays at various latitudes.

Now the simplicity of the foregoing picture is disturbed by the fact that the knee does not seem to vary with latitude as the altitude is varied, but seems to occur around 50° latitude for all altitudes. This led to the view that the origin of the knee was not to be explained by the absorption of low-energy rays by the atmosphere, but by something outside the atmosphere, something that creates, for the energy spectrum, a lower limit of energy which is nevertheless sufficiently great to permit penetration of the whole atmosphere. Under such conditions, the intensity versus latitude curve would show, at all altitudes, a knee corresponding to this energy.

To solve this paradox, it was suggested that the knee of the latitude curve owed its origin to the sun's magnetic field. The bending of the paths of the rays near the earth, that is, within a few earth radii, is caused mainly by the earth's magnetic field, which is here considerably stronger than the field of the sun. At greater distances from the earth, however, the sun's magnetic field predominates.

Consider a sphere containing the earth's orbit and centered at the sun. Then, neglecting the influence of the earth's magnetic field, we can ask what energy a cosmic ray of assigned type must have to enter that sphere at all in the vicinity of the earth's orbit, which orbit lies roughly in the plane of the sun's magnetic equator. No rays of energy less than this amount could reach the earth's orbit at all. If this energy is enough to penetrate the atmosphere, we would expect, as found, that the cosmic rays falling upon the earth would increase in intensity with increase of latitude from the equator only to the point at which all the rays permitted access

to the earth's orbit by the sun had been received by the earth. Increase of latitude beyond this point would yield no further rays because there would be no more rays. The knee of the latitude curve would occur at a definite latitude which would be the same for all altitudes.

The foregoing considerations become complicated by what happens to the primary cosmic rays as they enter our atmosphere. However, a fairly clean-cut story appears if observations are made so high in the atmosphere that down to that depth nothing in particular has happened to the primary rays. At such altitudes, and for the case where the primary radiation contains rays of all degrees of smallness in energy, we should expect the intensity to show a continual increase with latitude right up to the poles. (However, the matter is not quite as simple as here stated because even the small amount of atmosphere above the apparatus at high altitudes, and indeed the absorbing material in the apparatus itself, places a lower limit on the energy of the rays which can be observed.)

If the intensity of the magnetic field of the sun at its magnetic pole is known, we can calculate its value at the earth's orbit, and we can calculate the energy below which no rays are to be found striking the earth's atmosphere. We can then compute the corresponding latitude on the earth at which further increase of latitude would yield no additional rays, as these would have energies lower than those permitted by the sun to be present.

The magnitude of the sun's magnetic field has been debated for a long time, and particularly within recent years. Optical measurements of the Zeeman effect led, about 40 years ago, to the conclusion that the sun had a field of about 50 gauss at its pole. If the sun acted like an ordinary magnet, the corresponding field in the earth's vicinity would prevent protons reaching us if they had less energy than three billion electron volts, which is the energy for entry through the earth's magnetic field at the latitude of 50° geomagnetic. Consequently, on this basis, we should expect that even at the outer limits of the atmosphere there would be no increase of intensity with latitude from 50° to the pole.

However, recent experiments by M. A. Pomerantz, under the auspices of the Bartol Research Foundation, the Office of Naval Research, and the National Geographic Society, have shown that over the range of latitude from 52° to 69° there is an increase of 46 per cent in the vertical primary cosmic radiation intensity. Also, this radiation is composed of rays of such small energies that they could not possibly have come to us from outer space through the sun's magnetic field if it had more than six per cent of the strength originally assumed from the Zeeman effect.

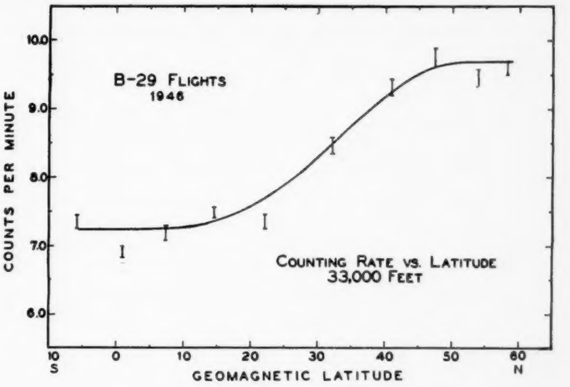
This argument should be accepted with reservation. There is increasing evidence that some primary rays may come to us from the sun itself, and such rays might reach us in spite of the sun's magnetic field because their short journey to us would not permit enough bending in their paths to keep them away from us. At the present time, the whole question of the magnitude of the sun's magnetic field and its bearing upon the primary cosmic rays calls for further elucidation.

Astronomers have come to doubt the existence of a solar magnetic field as high as 25 or 50 gauss at the poles of the sun. Indeed, G. Thiessen, who was originally one of the strongest supporters of the earlier value for the sun's field, concluded in 1949 that a strict analysis of the original data, while not denying the existence of the larger field, does not support such a field with any certainty. Moreover, his recent careful observations by improved methods, and those of others, using the new solar magnetograph, have led to a solar value of only about one gauss, and in the opposite direction to that formerly found.

On the other hand, observations of the solar field at one time do not necessarily guarantee its value at another. This warning is important, for some stars are known with certainty to possess variable magnetic fields. H. W. Babcock found in 1948 that the star HD 125248 has a magnetic field of 6,000 gauss at its pole, a field that reverses itself to a comparable value of opposite sign in a period of about 10 days. In *Sky and Telescope* for March, 1950, Otto Struve presented a detailed discussion of "Stars as Magnets."

Finally, in connection with cosmic magnetic fields, it has been suggested that the great galaxies of space may be the seats of magnetic fields. The magnetic fields in question are extremely small, of the order of 10^{-5} gauss, but their great extent makes them potent influences on the paths of the cosmic rays within the galaxy. Theoretical considerations show that a charged particle coming to the boundaries of such a region would be turned back into the galaxy as though the latter were provided with a reflecting wall, and similar considerations operate to prevent any cosmic ray which is outside the galaxy from entering it. Thus, on such an assumption, the cosmic rays within the galaxy would remain imprisoned within it forever or until destruction through collision with atoms or with other material in the galaxy, such as the stars, terminated their existence.

(To be continued)



How cosmic ray intensity varies with latitude is shown by these measurements made under Dr. Swann's direction in 1946 with airborne Geiger counter trains. As the number of counts per minute varies, each measured intensity has a statistical uncertainty, indicated by the length of the vertical line representing it. Note the leveling off of the curve at about 50° latitude.

CORRECTION: On page 224, May issue, the engraving was printed upside down.

PRECISION GYROSCOPE

Many new scientific and engineering uses for gyroscopes may result from a very sensitive improved form, recently developed by the Minneapolis-Honeywell Regulator Company for the Air Force. Its design was begun at the Massachusetts Institute of Technology, under Dr. C. S. Draper.

Like the familiar toy gyro, the new device is essentially a spinning rotor, mounted so that its axis maintains a fixed direction in space. The improved gyro, hundreds of times more sensitive than conventional forms, will hold the same direction to within 0.1 second of arc. This is approximately the angular size of an object on the moon 200 yards across. Such precision is made possible by floating the gyro in an oillike bath to reduce friction, and by driving it at a constant high speed, controlled by a crystal oscillator.

The new gyroscope was developed to guide supersonic planes and pilotless missiles, but already it has also been used successfully as a navigational aid for ocean-going vessels and for 60-ton tanks. Potentially, it may have purely scientific uses, since many problems in positional astronomy and geodesy depend, in principle, on comparing the direction of a star with the direction of some fixed line.

Some Eclipses of History and Legend

By Ralph S. Bates, *State Teachers College, Bridgewater, Mass.*

PERHAPS the earliest record of a solar eclipse is that found in the ancient Chinese classic *Shu King*. The Austrian astronomer Oppolzer thought this referred to an eclipse which occurred on October 22, 2137 B.C. At any rate it seems to have taken place during the reign of Chung K'ang, the fourth emperor of the Hsai dynasty. According to the legendary account, the two royal astronomers, Hsi and Ho, failed to predict the eclipse and were "too drunk in excess of wine" to perform the rites of shooting arrows and beating drums to chase away the dragon devouring the sun. As a punishment for the resulting confusion, the enraged emperor ordered their heads chopped off. This often repeated tale of the fate of Hsi and Ho is only a myth. It is most unlikely that anyone could have predicted eclipses at that date. Also, the eclipse cannot be identified with certainty; neither is the chronology of the Hsai dynasty very clear.

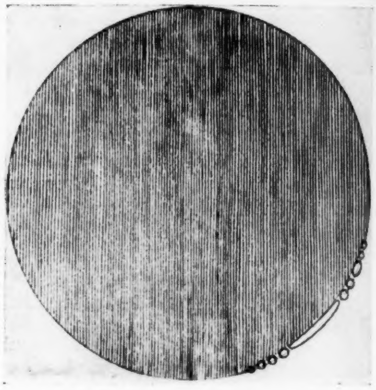
More trustworthy mentions of several other early eclipses of the sun are found in the writings of Confucius, especially in his *Ch'un Ch'iu*, a work used by the French Jesuit Gaubil in his pioneer study of Chinese astronomy published at Paris in 1770. The German chronologist Ideler remarked of the *Ch'un Ch'iu* that it gives an "account of 36 solar eclipses observed in China, the first of which was on February 22, 720 B.C. and the last on July 22, 495 B.C."

Many biblical scholars have sought to prove that *Amos 8:9* and *2 Kings 20:11* refer to a solar eclipse, possibly the total eclipse of 763 B.C. thought to have been visible in Palestine. Assyrian pictures of the winged sun may portray the sun in total eclipse with the corona showing.

The old Greek poet Archilochus wrote: "Zeus, the father of the Olympic gods, turned midday into night, hiding the light of the dazzling sun; an overwhelming dread fell upon men." Perhaps this is an allusion to the total eclipse of the sun on April 6, 648 B.C., which could have been seen from the northern part of the Aegean Sea.

The most famous eclipse of antiquity was that of May 25, 585 B.C., formerly supposed to have been predicted by Thales. The historian Herodotus describes the end of a long war between the Lydians and the Medes as follows: "As the balance had not inclined in favor of either nation, another engagement took place in the sixth year of the war, in the course of which, just as the battle was growing warm, day was suddenly turned into night. This event had been foretold to the Ionians by Thales of Miletus, who predicted it for the very year in which it actually took place. When the Lydians and the Medes observed the change they ceased fighting, and were alike anxious to conclude peace."

Throughout the Middle Ages, eclipses continued to be regarded with superstitious fear. The solar eclipse of May 5, 840, is even said to have so frightened Charlemagne's son, Louis the Pious, as to contribute to his death. In Scotland, the total eclipse of June 17, 1433, was long remembered as having produced the "Black Hour," while that of February 25, 1598, caused that day to be known as "Black Saturday."

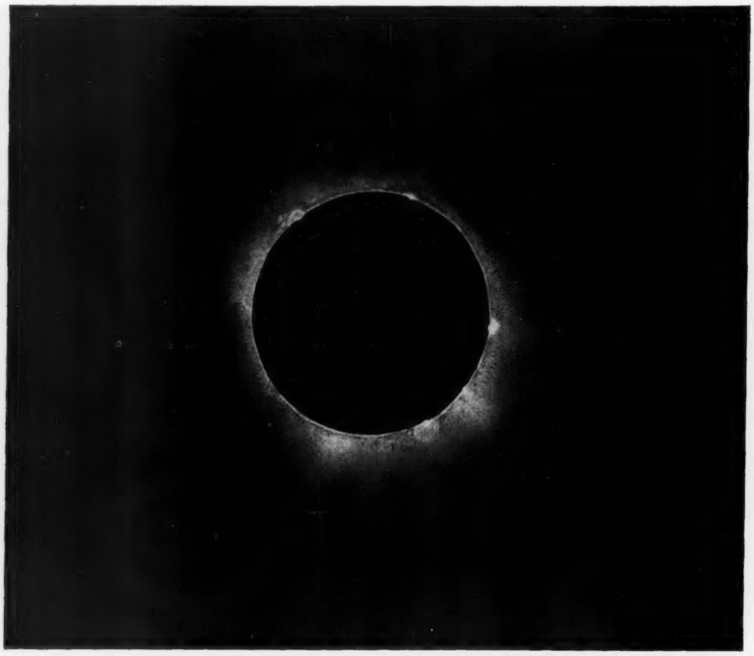


At the eclipse of October 27, 1780, Williams made this first drawing of what are now called Baily's beads.

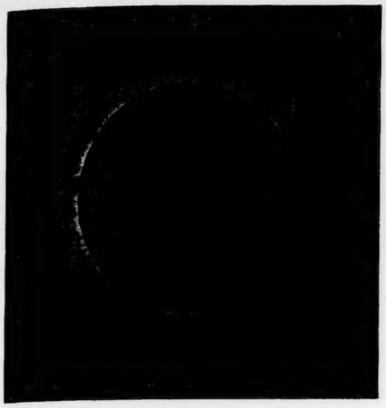
A more modern note is struck by the partial eclipse of the sun of May 30, 1612, which seems the first to have been seen "through a tube" or telescope, by Kepler at Linz.

Although the ancient authors Plutarch and Philostratus apparently allude to the corona, Kepler seems to have been the first to pay much scientific attention to it, at the eclipse of 1605 which he saw in Naples. The first distinct references to "red flames" or prominences probably date from the eclipse of 1706, when Captain Stannyan observed them at Berne and wrote Flamsteed about them.

One of the most interesting episodes in the early history of American astronomy was the Harvard eclipse expedition of 1780. Although the Revolutionary War was still in progress, the Massachusetts legislature passed a resolution to fit out the *Lincoln* galley to convey Samuel Williams, of Harvard, and his party to Penobscot Bay, Maine. The expedition was allowed by the British fleet to proceed on its mission. Ironically, the astronomers had miscalculated the eclipse and stationed themselves just outside the zone of totality. This resulted in Williams discovering (or at any rate giving the first clear description



Photography of eclipses opened the way to understanding the nature of the sun's corona, which is shown here as it appeared on the first daguerreotype of the corona, taken by Berkowski on July 28, 1851.



Compare this drawing of the 1851 eclipse, by G. P. Bond, of Harvard, with the daguerreotype on the facing page.

of) what later came to be known as Baily's beads.

Williams' description reads in part: "Immediately after the last observation, the sun's limb became so small as to appear like a circular thread, or rather like a very fine horn. Both the ends lost their acuteness, and seemed to break off in the form of small drops or stars; some of which were round and others of oblong figure. They would separate to a small distance: Some would appear to run together again, and others diminish until they wholly disappeared." Francis Baily described the same phenomenon in connection with an annular eclipse on May 15, 1836, that was visible in the northern parts of Great Britain.

The advent of photography opened a new chapter in the study of the sun. The first attempt at solar eclipse photography was made by G. A. Majocchi, of Milan, at the total eclipse of July 8, 1842. Using both daguerreotypes and bromide paper, he succeeded in photographing only the partial phases. The corona was first daguerreotyped by Berkowski at Koenigsberg on July 28, 1851. This photograph was exhibited at the 1893 World's Fair. Far from the path of totality, J. A. Whipple at Harvard also made daguerreotypes of this eclipse.

The first photographs of the sun's corona taken in America were on August 7, 1869, by E. C. Pickering, then professor of physics at the Massachusetts Institute of Technology, and by Whipple on the Harvard eclipse expedition to Shelbyville, Ky.

In 1881 David P. Todd brought out the importance of telegraphy for eclipse observations. Observers noting any peculiar feature at totality could forewarn others farther to the east, where totality would begin later. Astronomers made elaborate preparations at the January 1, 1889, eclipse to send data along the path of totality over the Western Union wires. In this they were aided by the enterprise of the well-known journalist, James Gordon Bennett.

From the scientific standpoint, the most notable eclipse of the early 20th century was that of May 19, 1919. One observational test of relativity theory was to see whether there would be an apparent outward displacement of stars near the sun. On the general theory of relativity, a ray of light passing near the sun would be bent by the sun's gravitation, and the maximum displacement would be 1.75 seconds of arc for a star at the sun's limb. Since stars can be observed near the sun only during a total eclipse, measuring the displacement became a problem of great interest to eclipse observers.

This effect was first sought at the 1919 eclipse by two English expeditions, one under A. S. Eddington to South Africa, the other under A. C. D. Crommelin to Brazil. The sun happened to be among the bright stars of the Hyades. The best series of plates gave a shift of 1.98 $\pm$ 0.12 seconds of arc — in fair agreement with the value predicted by the Einstein theory. A closer agreement was shown by the next test, at the Australian total eclipse of September 20, 1922, when parties from Canada and from the Lick Observatory found 1.78 and 1.75 seconds, respectively.

Similar observations have been made several times since, but they are very delicate and liable to subtle sources of error. Thus, the Einstein shift remains an important item for future eclipse programs, whenever the sun is located in a sufficiently rich star field.

French Astronomers' Eclipse Plans

BY SARAH LEE LIPPINCOTT

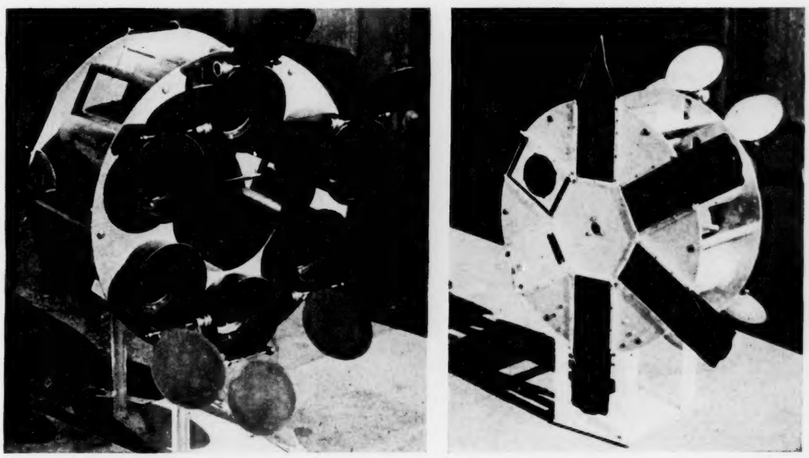
THIS MONTH'S eclipse takes place at a time of minimum solar activity, when sunspots are few and far between, chromospheric eruptions are scarce, and the corona should have typical equatorial streamers. Although, as described elsewhere in this issue by Dr. Donald E. Billings, the corona has been observed outside of eclipse for two decades, the artificial eclipse of a coronagraph cannot eliminate all the light diffused by the earth's atmosphere. Therefore, a great portion of our knowledge of the corona must still come from observations at the rare moments of totality.

French astronomers will head north to the slim little island, Oland, off the east coast of Sweden. There is about a 50-50 chance for clear conditions at eclipse time, but the duration of totality is about 2½ minutes, nearly the maximum for this eclipse, and the sun will be high in the sky near the noon point.

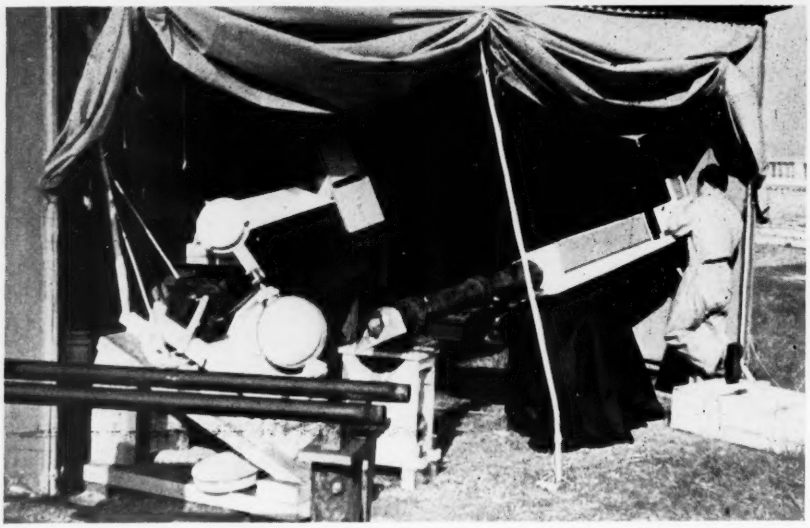
The principal optical observations will be carried out by the Meudon Observatory, where L. d'Azambuja is head of the solar division. Also included in the expedition under the leadership of R. Michard are Mme. d'Azambuja, A. Dollfus, G. Olivieri, and R. Servajean.

There are two coronal spectrographs, veterans from the 1952 eclipse in Africa, one for visual, the other for ultraviolet wave lengths. The ultraviolet region is the most difficult to observe outside of eclipse. Instead of the usual straight-line slits, two semicircular slits are concentric with the sun's eclipsed image and are adjusted so that light from a ring of the corona at a predetermined distance from the center of the sun is used. The optical system displaces one of the semicircular images vertically, thus yielding two rows of curved spectra on the same plate.

The radiation producing the different parts of the semicircles are the corre-



These are six of the eight cameras to be placed on one mounting. In the rear view at the right, four of the plateholders are ready for exposures.



Two Meudon Observatory eclipse spectrographs, one each for visual and ultraviolet light, will be set up in Sweden. The mirrors at the left feed sunlight into the horizontal optics of these stationary instruments.

sponding angular parts of the corona itself. Due to the extremely complex structure of the corona, the intensity of the emission spectrum varies greatly from one place to another, so that the bright lines do not have uniform intensity throughout their length. At the 1952 eclipse, 20 lines were observed that could be arranged in four groups according to their similar positions of maximum and minimum intensities. In other words, certain conditions in the corona give rise to certain lines and not to others. It will be of interest to determine if all these lines are visible on June 30th, or if others appear in place of some of them.

Following in the lineup of instruments is a telescope mounted with a Lyot filter isolating the red and green coronal lines simultaneously. One short exposure will be made at the first moment the sun's disk is completely covered, in order to record together the chromosphere and the corona at the point of contact. A similar photograph at third contact will show these two regions on the opposite limb of the sun. Coronagraph observations suffer from the greater diffusion of light immediately around the sun. With the above photographic procedure, it is hoped to record the generally unobserved but very important region, only about 1/50 the sun's radius in width, where the transition from the relatively cool chromosphere to the intensely hot corona takes place.

During mid-totality the moon's disk will be enough larger than that of the sun to hide the entire chromosphere. During that time a long exposure will be taken through the Lyot filter to show details of the outer coronal regions in these two wave lengths. Similar filters will be used at the Pic du Midi Observatory at the same time, and a comparison of total eclipse and coronagraph photographs will permit evaluation of the completeness of day-to-day observations with the artificial eclipses of the coronagraph.

Next in line is a telescope of 6½-foot focal length to work in the red and in polarized light. Since the light from the corona near the sun's edge is more than a thousand times brighter than the visual radiation from the outer portions, a carefully graduated neutral filter will be placed above the photographic plate to procure the same effective exposure for all the regions recorded. From the known properties of the filter, true relative differences in intensity should be measurable for all parts of this plate.

Another camera, yielding a field of six or seven times the sun's diameter, will be used with a red filter and an opaque screen in rapid rotation in front of the photographic plate. The rotating screen will serve the same purpose as the graded neutral filter in the case above, allowing more light to pass at greater distances from the sun's limb. It is hoped to record details of the inner and outer corona on the same exposure.

Another piece of the Meudon equipment carries eight cameras mounted together, all having an occulting system that eclipses a circular area twice the sun's diameter. In this way the light of the inner corona will be eliminated, for infrared and red photographs, and also for studies of the polarization of the corona. The white-light corona has two components. The K-corona is an actual extension of the sun's atmosphere, and is the subject of Dr. Billings' article this month; the F-corona is believed to be contributed by the reflection and diffraction by interplanetary particles and may be a part of the zodiacal light, the subject of the article by Drs. Frank E. Roach and G. Van Biesbroeck in March. The light of the true corona is polarized, that of the F-corona is not. Hence, observations in polarized light may aid us in separating these phenomena where they presumably blend strongly near the edge of the solar disk.

Another means of observing the F-corona is by its "reflection" of the sun's dark-line or Fraunhofer spectrum. The K-corona is too hot to permit the occurrence of the red hydrogen-alpha line that is so prominent in the sun's spectrum. Hydrogen-alpha photographs, through a Lyot filter, will be obtained to show the distribution of intensity of the F-corona in the outer coronal regions.

Besides the optical equipment, there will be a radio telescope with which M. Laffineur, of the Astrophysical Institute, will receive radiation at wave lengths of 55 centimeters and 1.8 meters. Although the resolving power of the radio telescope is not very great, it will be of value to compare the general distribution of intensity in these long waves to that in the visual range.

If clouds should prevent optical observations of the total eclipse, the radio observations could still be compared with the Pic du Midi records for the same time. If these also are not possible because of bad weather in the Pyrenees, coronagraph photographs taken half a solar rotation period before and after the eclipse must be employed to reconstruct an approximation of the corona shape of June 30th. Comparison can also be made with the records of other coronagraphs, including those in Germany, Switzerland, Colorado, and New Mexico.

Another radio telescope project is to be carried out jointly by the Royal Observatory of Belgium and the Ecole Normale Superieure, where J. F. Denisse works in the radio range. In this case there will be seven observing stations. One will be a control, in the Belgian Congo completely outside the partial eclipse area; one will be in the path of totality on the west coast of Sweden, and the others in areas where the eclipse is partial. By comparing the records of all these radio telescopes (on a 2-meter wave length), it will be possible to build up a picture of intensity distribution with a resolving power superior to that possible with any single instrument. This joint project also includes observations at 30 centimeters at the Paris, Belgium, and Sweden stations.

Ed. Note: The foregoing article has been prepared by Miss Lippincott while on a Fulbright fellowship at the Meudon Observatory in France, on leave from her position on the staff of the Sproul Observatory, Swarthmore, Pa. She will herself observe the eclipse from the island of Oland, Sweden.

Eclipse Notes

British Astronomical Association: An additional tour to those announced in *Sky and Telescope,* January, 1954, page 71, is scheduled to fly from London to Gothenburg, Sweden, on June 28th and return by plane to London the night of the 30th. Observing will be from Lysekil, the town at which the main RAS-BAA expedition will be based. An optional one-hour flight will be made from Gothenburg if weather looks bad on eclipse morning.

Reservations are being arranged by C. A. G. Bearpark, Boniwell and Co., St. Marks Hill, Surbiton, Surrey, England.

New York AAA: The Amateur Astronomers Association plans to establish a site just north of Minneapolis, close to the central line. The photography program will include both still and motion pictures of all phases in both color and black and white. Equipment will include a 4-inch refractor of 10 feet focal length and an electrically driven movie camera with variable shutter-speed control. Shadow band photography will be attempted. The program also includes visual observations, timing of contacts, measures of variations in light, and meteorological phenomena. The general program will closely follow that for the 1945 eclipse (*Sky and Telescope,* October, 1945, page 12).

Between 25 and 50 AAA members are expected to make the trip. The eclipse committee is under the chairmanship of George V. Plachy.

Fairmont Amateur Astronomers: Some members of the Fairmont Amateur Astronomers Association will have an observing station at Coral Rapids, Ont., which they will reach by driving to Cochrane and then taking the train. Anyone in the West Virginia area interested in going should communicate with David D. Meisel, 800 Eighth St., Fairmont, W. Va.

ECLIPSE WEATHER BROADCASTS

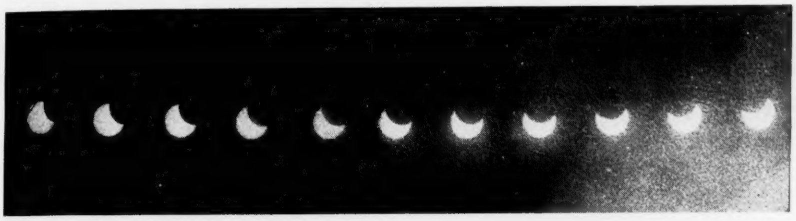
Radio weather broadcasts from the Weather Bureau airport station at Minneapolis are being planned for the evening of June 29th and the very early hours of June 30th, just before the total eclipse. In addition to a forecast of expected weather conditions at dawn for numerous key locations along and near the path of totality in southern Minnesota, northern Wisconsin, and upper Michigan, we intend also to give a little information on the eclipse itself.

The regular weather broadcasts on WMIN, Twin Cities, at 5:30 p.m. and on WCCO, Minneapolis, at 6:00 p.m. of the 29th will contain a preliminary forecast, but these will present other routine weather information also. A special broadcast at 11:05 p.m. over these two stations simultaneously—WCCO (830 kilocycles) and WMIN (1400 kilocycles, FM 99.5 megacycles)—will be considered our principal eclipse weather roundup. Because WMIN is on the air several hours beyond midnight, we shall present one additional broadcast at 2:00 a.m. on the 30th, on that station.

On each broadcast we shall include up-to-the-minute spot weather, not only from our regular hourly airway reporting stations, but also from co-operative observers recruited for the occasion.

Any amateur weathermen in this area who would like to contribute to our reporting network that night may reach us in Minneapolis at DUpont 7182 or St. Paul at NEstor 5421.

P. W. KENWORTHY
Meteorologist-in-charge
USWB Airport Station
Minneapolis, Minn.



The eclipse of July 9, 1945, was of magnitude 0.57 at Philadelphia, where Dr. George Rosengarten took this series photograph. Maximum obscuration in the same city on June 30th will be 73 per cent.

Place	Beginning	P	V	Middle	Magnitude	Ending	P	V
	h m	°	°	h m		h m	°	°
Albany, N. Y.	10 07	284	331	11 02	0.78	12 02	78	131
Amherst, Mass.	10 07	285	332	11 02	0.76	12 02	77	130
Ann Arbor, Mich.	10 09	279	323	11 02	0.87	11 59	83	134
Appleton, Wis.	.. ..	...	...	11 06	0.95	12 02	88	137
Atlanta, Ga.	.. ..	...	...	10 53	0.68	11 47	71	130
Augusta, Maine	10 08	284	330	11 05	0.78	12 06	79	130
Austin, Tex.	.. ..	...	...	.. ..	[0.26] [1]	11 46	75	132
Baton Rouge, La.	.. ..	...	...	.. ..	[0.59] [1]	11 44	71	131
Bismark, N. Dak.	.. ..	...	...	11 13	0.91	12 06	97	141
Buffalo, N. Y.	10 08	281	326	11 02	0.83	12 01	81	133
Cambridge, Mass.	10 07	286	333	11 02	0.75	12 02	76	130
Charleston, W. Va.	.. ..	...	...	10 57	0.76	11 54	77	133
Charlottesville, Va.	10 05	287	336	10 57	0.72	11 53	74	131
Cheyenne, Wyo.	.. ..	...	...	.. ..	[0.62] [1]	12 01	93	140
Cincinnati, Ohio	.. ..	...	...	10 59	0.81	11 55	79	133
Cleveland, Ohio	10 08	282	326	11 01	0.83	11 59	81	134
Columbia, Mo.	.. ..	...	...	11 01	0.88	11 55	83	136
Columbia, S. C.	.. ..	...	...	10 53	0.65	11 46	69	129
Columbus, Ohio	.. ..	...	...	11 00	0.81	11 56	80	133
Denver, Colo.	.. ..	...	...	.. ..	[0.48] [1]	12 00	91	139
Des Moines, Iowa	.. ..	...	...	11 05	0.95	11 59	88	137
Dover, Del.	10 05	288	337	10 57	0.72	11 55	74	130
Evanston, Ill.	.. ..	...	...	11 03	0.90	11 59	85	136
Geneva, N. Y.	10 08	282	328	11 02	0.82	12 01	80	132
Greencastle, Ind.	.. ..	...	...	11 00	0.84	11 56	81	135
Hanover, N. H.	10 08	284	330	11 03	0.79	12 04	79	130
Harrisburg, Pa.	10 06	286	333	10 59	0.76	11 57	77	131
Helena, Mont.	.. ..	...	...	.. ..	[0.60] [1]	12 09	103	143
Iowa City, Iowa	.. ..	...	...	11 04	0.93	11 59	86	137
Ithaca, N. Y.	10 07	283	329	11 02	0.80	12 01	79	132
Jackson, Miss.	.. ..	...	...	.. ..	[0.70] [1]	11 46	73	131
Juneau, Alaska	.. ..	...	...	.. ..	[0.46] [1]	12 26	123	148
Kansas City, Mo.	.. ..	...	...	11 02	0.90	11 56	85	136
Lake Angelus, Mich.	10 10	279	323	11 03	0.87	12 00	83	134
Little Rock, Ark.	.. ..	...	...	.. ..	[0.78] [1]	11 50	78	134
Louisville, Ky.	.. ..	...	...	10 58	0.80	11 54	79	134
Madison, Wis.	.. ..	...	...	11 05	0.94	12 01	87	137
Minneapolis, Minn.	.. ..	...	...	11 08	1.01 [2]	12 03	92	138
Montgomery, Ala.	.. ..	...	...	10 53	0.67	11 45	70	130
Nashville, Tenn.	.. ..	...	...	10 56	0.76	11 51	76	133
New Haven, Conn.	10 06	286	334	11 00	0.74	12 00	76	130
New Orleans, La.	.. ..	...	...	.. ..	[0.60] [1]	11 43	69	130
New York, N. Y.	10 06	286	335	11 00	0.74	11 59	76	130
Oklahoma City, Okla.	.. ..	...	...	.. ..	[0.64] [1]	11 53	82	136
Omaha, Nebr.	.. ..	...	...	11 05	0.96	11 59	88	138
Orono, Maine	10 09	284	330	11 06	0.79	12 08	79	129
Oxford, Miss.	.. ..	...	...	10 56	0.75	11 49	75	133
Philadelphia, Pa.	10 05	287	335	10 59	0.73	11 57	75	130
Pierre, S. Dak.	.. ..	...	...	11 10	0.96	12 03	94	140
Pittsburgh, Pa.	10 07	284	330	10 59	0.79	11 57	79	132
Poughkeepsie, N. Y.	10 06	286	333	11 01	0.76	12 00	77	131
Raleigh, N. C.	10 03	291	341	10 54	0.67	11 49	71	129
Richmond, Va.	10 04	289	339	10 56	0.70	11 52	72	130
San Juan, P. R.	10 16	337	49	10 38	0.07	11 00	20	96
Santa Fe, N. Mex.	.. ..	...	...	.. ..	[0.10] [1]	11 56	87	138
Springfield, Ill.	.. ..	...	...	11 01	0.87	11 56	83	135
St. Louis, Mo.	.. ..	...	...	11 00	0.85	11 55	82	135
Syracuse, N. Y.	10 08	282	328	11 02	0.81	12 02	80	132
Tallahassee, Fla.	.. ..	...	...	10 50	0.60	11 41	66	128
Topeka, Kans.	.. ..	...	...	.. ..	[0.87] [1]	11 56	85	137
Tuscaloosa, Ala.	.. ..	...	...	10 54	0.70	11 47	72	131
Urbana, Ill.	.. ..	...	...	11 01	0.86	11 56	83	135
Washington, D. C.	10 05	287	336	10 57	0.73	11 55	75	131
Williams Bay, Wis.	.. ..	...	...	11 04	0.92	12 00	86	136

[1] Magnitude at Sunrise. Mid-eclipse below horizon.
[2] Duration of total phase $1.^{m}2$.

CIRCUMSTANCES OF THE PARTIAL ECLIPSE IN THE UNITED STATES

These are Universal times; to get Eastern standard time subtract 5 hours; Central time, 6 hours; and so on. As an example, at Albany, N. Y., the eclipse begins at 5:07 a.m. EST, when the first notch in the sun is in position angle 284°, or 331° from the top of the sun's disk, measured counterclockwise around its edge; greatest obscuration there is at 6:02 a.m. EST, with 0.78 of the sun's diameter covered. The last three columns give data for the end of eclipse. Dots mean that the sun is below the horizon. From the "American Ephemeris and Nautical Almanac."

NEWS NOTES

By Dorrit Hoffleit

STELLAR ASSOCIATIONS AND SUPERNOVAE

"Theoretical difficulties in following up the phenomena are great, chiefly on account of the multitude of the factors involved; but the observational facts are so eloquent that a mistake in their general interpretation is hardly possible."

Thus does E. J. Opik, of the Armagh Observatory, introduce his theory on a common origin for such diverse objects as expanding shells around supernovae, the giant hydrogen rings in Orion and in the Large Magellanic Cloud, loose stellar associations like the Ursa Major cluster or stars in a group that appear to have expanded from a common center. His discussion is published in the December, 1953, issue of the *Irish Astronomical Journal.*

Dr. Opik qualitatively proposes that the expanding shell of a supernova pushes ahead and collects in a compressed form the interstellar gas that is already present in its neighborhood. As the mass of the shell increases by accretion of the interstellar material, the velocity of expansion decreases. When the shell's motion has been slowed to a few kilometers per second, the shell may have attained a mass of several thousand suns, sufficient for condensation into tens or even hundreds of stars, allowing for the probable dispersion of most of the matter into space.

HARVARD OBSERVATORY'S NEW OFFICE BUILDING

The Great Comet of 1843 started Harvard College Observatory on its original building program. In August of that year, ground was broken on "Summer House Hill" in Cambridge, Mass., for the erection of the Sears Tower to house the 15-inch refractor that was installed in June, 1847. By September, 1844, the director's residence and office quarters had been completed to permit removal of the observatory headquarters from Dana House. In December, 1851, the west wing, final unit of the original building plan, was ready for occupancy.

The west wing, known as Building A, for many years housed the headquarters of the American Association of Variable Star Observers. It has now been razed to make room for a modern building that will contain 26 offices, a large lecture room, and a smaller conference room. All of the other original wooden buildings will eventually be torn down, but the Sears Tower, of brick, will remain and continue to house the Great Refractor.

At brief ceremonies on April 20th, Dr. Donald H. Menzel, director of the observatory, displayed the contents of a copper container that has been sealed in the cornerstone of the new building. Included are documents on the history of the observatory, records of current achievements, photographs of the newest Harvard instruments, and a group picture of the witnesses to the ceremony, some 100 staff members and friends.

WHERE TO LAND ON THE MOON

Selenography is applied to a practical problem by H. Percy Wilkins in the March *Journal* of the British Interplanetary Society. What parts of the lunar surface will be most suitable for landing sites when travel to our satellite becomes a reality?

From his experience in lunar observations with telescopes up to 33 inches in aperture, Dr. Wilkins stresses the small-scale roughness of the moon's surface. Areas that appear as smooth expanses in smaller instruments are found with increased optical power to be greatly pitted and fissured. Dark regions are apt to be smoother than bright regions, if Wilkins is right in thinking the latter too jagged to be uniformly blanketed by the dust that covers most of the moon.

Thus darker areas like the interiors of the craters Archimedes and Plato seem the most suitable for landing. But the landing site itself would be a mere dot in the largest telescopes, and so there will be no substitute for detailed reconnaissance within a few miles of the moon's surface. Evidently the spaceship must be readily maneuverable just before landing.

IN THE CURRENT JOURNALS

QUANTUM MECHANICS AND THE AETHER, by P. A. M. Dirac, **Scientific Monthly,** March, 1954. "I would be quite willing to give up all idea of the aether if a satisfactory theory could be set up without it. It is only the failure of the world's physicists to find such a theory, after many years of intensive research, that leads me to think that the aetherless basis of physical theory may have reached the end of its capabilities and to see in the aether a new hope for the future."

ATOMS AND IONS IN THE SUN, by Charlotte E. Moore, **Science,** April 9, 1954. "The over-all range of solar spectrum observations, exclusive of Lyman α of H at 1216 A, is from about 1850 A to 24,000 A (2.4μ). No student of cosmic abundances can overlook such an impressive array of spectroscopic material from our nearest star. In the region photographed with high dispersion (2950 A to 13,495 A), 26,000 lines of various intensities have been recorded, of which about 70 per cent are wholly or partially identified."

WALTER BAADE HONORED

Dr. Walter Baade, of the Mount Wilson and Palomar Observatories, has been awarded the gold medal of the Royal Astronomical Society, its highest honor, for his observational work on galactic and extragalactic objects. He discovered the existence of two stellar populations among the stars in the Andromeda nebula, our Milky Way, and other galaxies. This discovery laid the groundwork for his observations of M31 that showed the necessity for revision of the distance scale of the universe.

Three other Mount Wilson astronomers have received this same honor: George E. Hale, Walter S. Adams, and Edwin P. Hubble.

"FLARE" STARS IN ORION

Dr. Guillermo Haro, of the Tonanzintla Observatory, Mexico, reports the discovery of seven new flare stars in the Orion nebula. Together with the three that he and W. W. Morgan found earlier, this brings to 10 the number of flarelike stars discovered in only one square degree centered on the Trapezium. Most of the time these stars are very faint. The seven new ones are between magnitudes 16.4 and 17.6 at minimum. When a flare occurs, the star's brightness increases by anywhere from 0.5 to two magnitudes in five to 30 minutes, folowed by slower fading.

WALTER GROTRIAN

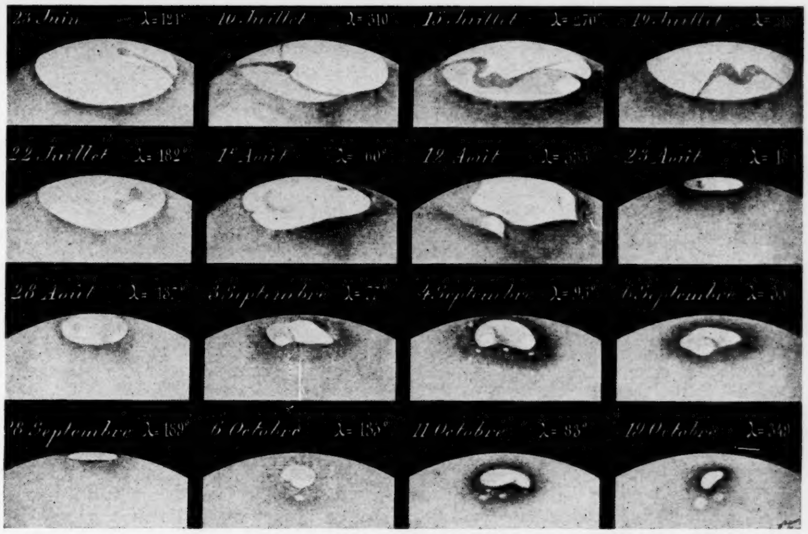
German astrophysics has lost one of its outstanding figures by the death in early March of Dr. Walter Grotrian. Born at Aachen on April 21, 1890, Grotrian joined the staff of the Potsdam Astrophysical Observatory in 1922, and became its director on January 1, 1951.

His name is familiar to all atomic scientists and astrophysicists for his "Grotrian diagrams" which did so much toward simplifying the complex problems of spectrum analysis. In astronomy, Grotrian's chief interest was the sun, notably sunspots, the corona, and magnetic fields and their effects on our ionosphere. Others of his writings deal with the interpretation of the spectra of diffuse and planetary nebulae, and with cosmology. He also contributed the lengthy section on series relations in line spectra in the *Handbuch der Astrophysik,* the astronomer's encyclopedia.

With A. Unsöld, of Kiel, Grotrian was co-editor of the German astrophysical journal, *Zeitschrift für Astrophysik.*

AN OPERA ON KEPLER

The *Journal* of the British Astronomical Association notes that Paul Hindemith, the well-known composer and conductor, is writing an opera on the life of Johann Kepler. Symphonic extracts from the work have already been performed at Edinburgh.



The shrinkage of Mars' south polar cap in 1954 may follow much the same pattern as in 1909, when these drawings were made between June 23rd and October 19th by G. Fournier with a 14½-inch refractor. The orientation of the rifts changes as the planet rotates, so that the longitude of the central meridian is given for each sketch. Note the dark "melt-band" and the "detached snowfields." From the "Observations" of the Observatoires Jarry-Desloges.

Mars and the Amateur Observer

By Walter H. Haas, *Director*
Association of Lunar and Planetary Observers

LIKE THE CAT in an old popular song, the planet Mars always comes back, and in fact at intervals of about two years. It is then a favorite with every observing amateur, and some professional astronomers give the red planet more than casual attention. The season of Mars fever is again upon us, for the planet will be at opposition on June 24, 1954. Its closest approach to the earth will come a little later, on July 2nd, when its angular diameter will be 22 seconds, so that a power of 85x on a telescope will show its disk as large as the moon appears to the naked eye.

The approach will be the closest since 1941, though Mars will come closer still in 1956. Observers in the Northern Hemisphere will be severely handicapped this year, however, by the fact that the planet will be far south of the equator; on the date of closest approach its declination will be 28° south. Its meridian altitude will then be 11 degrees in London (yet we venture to predict some first-class observational work in the British Isles!), 21 degrees in New York, 28 degrees in Los Angeles, and 36 degrees in Miami.

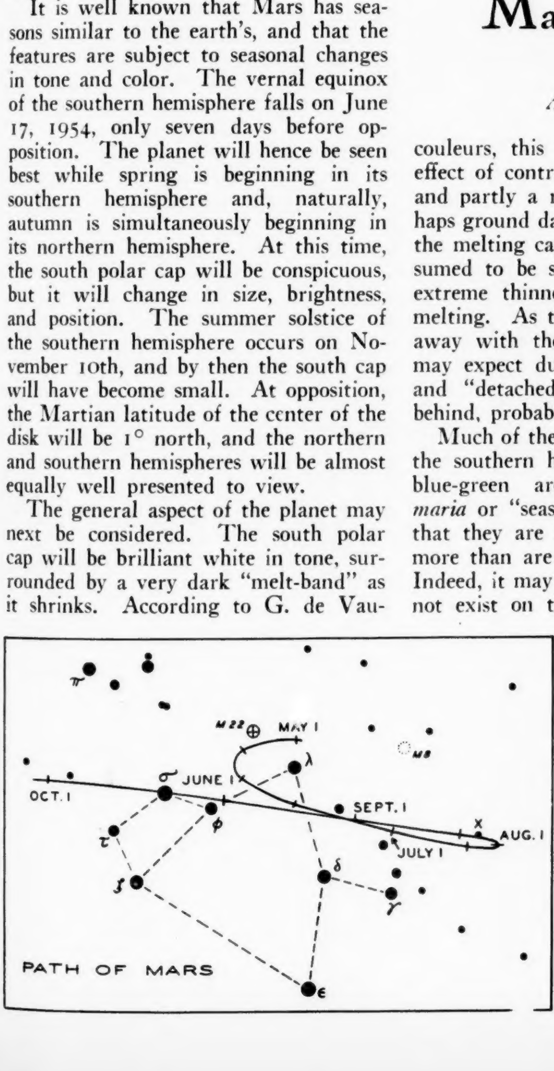
It is well known that Mars has seasons similar to the earth's, and that the features are subject to seasonal changes in tone and color. The vernal equinox of the southern hemisphere falls on June 17, 1954, only seven days before opposition. The planet will hence be seen best while spring is beginning in its southern hemisphere and, naturally, autumn is simultaneously beginning in its northern hemisphere. At this time, the south polar cap will be conspicuous, but it will change in size, brightness, and position. The summer solstice of the southern hemisphere occurs on November 10th, and by then the south cap will have become small. At opposition, the Martian latitude of the center of the disk will be 1° north, and the northern and southern hemispheres will be almost equally well presented to view.

The general aspect of the planet may next be considered. The south polar cap will be brilliant white in tone, surrounded by a very dark "melt-band" as it shrinks. According to G. de Vaucouleurs, this dark fringe is partly an effect of contrast with the brilliant cap and partly a real physical feature, perhaps ground dampened by moisture from the melting cap. The cap itself is presumed to be snow or ice, doubtless of extreme thinness in view of its rapid melting. As the southern cap dwindles away with the advance of spring, we may expect dusky rifts to appear in it and "detached snowfields" to be left behind, probably on higher ground.

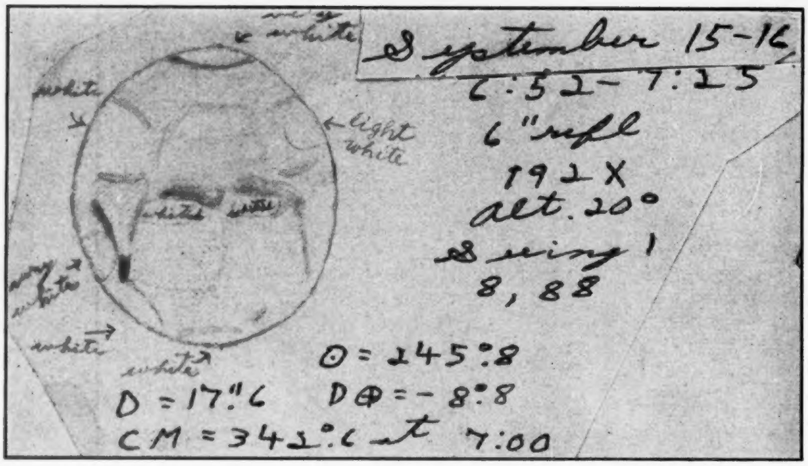
Much of the globe of Mars, especially the southern hemisphere, is covered by blue-green areas. These are called *maria* or "seas," but it is quite certain that they are not bodies of water any more than are the "seas" of the moon. Indeed, it may be that liquid water cannot exist on the surface of Mars; ice may pass directly into water vapor because of the slight atmospheric pressure. Perhaps the maria are actually areas covered by some kind of vegetation, such as lichens, for their changes in color and tone with the seasons strongly suggest the growth in spring and summer and decay in autumn and winter of some kind of plant adapted to the rigorous Martian climate. The necessary moisture would have to come from the melting of the polar cap.

The bright parts of the globe show a red or ochre tint and are certainly deserts; they may owe their color to oxides of iron, which interpretation may explain the lack of oxygen in the planet's atmosphere. The deserts, and the maria as well, are criss-crossed by a network of bandlike markings called canals. Here the god of war of the ancients has indeed provoked a modern battle.

Some observers, led for many years by Percival Lowell, founder of the Lowell Observatory at Flagstaff, Ariz., have seen the canals as very thin lines, often doubled, extending for long distances along great-circle arcs on the surface of Mars and altogether of a remarkable geometric regularity which it is hard to impute to natural causes. Others, long championed by E. M. Antoniadi at the Meudon Observatory near Paris, consider such geometric canals illusions; to them the canals are wide, diffuse, and splotchy markings by no



During this opposition period, Mars will remain practically continuously in the constellation of Sagittarius, pursuing the looped path shown here. On September 20th, the planet will pass less than two minutes of arc south of the 2nd-magnitude star Sigma Sagittarii.



A working drawing of Mars by the author with a 6-inch reflector on September 16, 1939. The observing book reads: "The drawing is fairly good; one assuredly sees most when the planet first becomes visible on a twilight sky. Nilosyrtis was the most easily visible canal, and Gehon was next; Protonilus and Euphrates were very delicate. Note Acidalium on the terminator. The south cap was minute and may be drawn too large. Hellas was the whitest area south of the 'diaphragm'; Pyrrhae came next; Deucalionis and Noachis were less dull than Australe or Erythraeum."

means continuous when they are well seen in large telescopes, and indeed they maintain that some canals are only boundary lines between regions of slightly different tone. Others have even denied that the canals exist.

We cannot take this last point of view too seriously, for the canals have been seen as some kind of bandlike markings by almost every serious student of Mars and have been photographed; but we must admit that their true appearance is very uncertain. It is not likely that visual observations in the future will solve the riddle of the canals, and yet many a worthy planetary student will keep trying to see what the canals look like to *him* when a fleeting moment of excellent definition comes along.

Perhaps photographs with the Hale 200-inch telescope will tell us something. Lowell regarded the so-called canals as literally canals, artificial waterways dug by an intelligent race of Martians to preserve life on their very dry planet. His writings on the subject are most readable literature, whatever their scientific merits or shortcomings. Yet practically all astronomers prefer a natural explanation. For instance, C. Tombaugh suggested that the oases, round, dark spots at the junctions of canals, might be impact craters (like Meteor Crater in Arizona) where large meteorites or small asteroids struck and exploded on the surface of Mars, and that the canals are cracks formed by these impacts, now filled with a growth of lichens.

Besides these permanent markings on the red planet, there are temporary features — in other words, clouds. These fall into two general classes. The "blue" clouds (white in color to the visual observer and prominent on photographs in blue or violet light) attain heights of six to 19 miles in the Martian atmosphere, and are probably composed of ice crystals like our own cirrus clouds. The "yellow" clouds rise only two or three miles above the surface of Mars, and are perhaps composed of dust and sand raised from the surface by winds. One of the riddles of the Martian atmosphere is its obscuring "violet layer" of uncertain nature and composition, a veil which usually prevents us from photographing surface detail in blue light. Yet sometimes the violet layer mysteriously clears away for a few days.

Modern astrophysics has learned much about physical conditions on our neighbor world. The temperature in low latitudes at noon may reach 85° F. and in middle latitudes at noon varies from about +5° in the winter to about +70° in the summer. The nights are extremely cold, with temperatures far below zero even at the equator. It is known that carbon dioxide gas exists in the atmosphere — the one positive identification of an atmospheric constituent in 80 years of Martian spectroscopy. Presumably the chief gas in the Martian atmosphere is nitrogen. The amount of oxygen is less than 0.1 per cent as much as in the atmosphere of the earth, and water vapor is so scarce that it has so far resisted detection by spectroscopic methods. It might, however, prove very instructive to search for water vapor at the edge of a rapidly melting polar cap, such as the south cap this August.

The surface atmospheric pressure is difficult to determine, but may be near two to 2.5 inches of mercury, corresponding to the pressure at a height of about 11 miles above the surface of our own planet. We should bear in mind, however, that with the smaller surface gravity of Mars — 3/8 that on earth — the atmosphere will decrease in density with increasing altitude much less rapidly than does our own air. This circumstance must help explain the great elevation reached by the Martian blue clouds.

Much of the work of the Mars committee programs will require special professional equipment (see page 251), but there is definite use for careful visual observations by the amateur with a small telescope of good optical quality. Just what equipment does the amateur need? What studies of Mars can he undertake?

To the first question, the encouraging answer can be given that some talented observers have done good work with only 3- and 4-inch telescopes. A 6-inch will prove more satisfactory, however, and the fortunate possessor of a still larger telescope will enjoy even better views of Mars. It is true that there will be fewer nights when the optical possibilities of large instruments can be fully exploited. Never forget that planetary work demands optics of great excellence; mirrors quite suitable for estimating variable stars and searching for comets may prove most disappointing.

One of the easiest amateur projects is drawing the planet. The observer simply sketches, at the eyepiece, what he sees on the ruddy globe. He must wield a fairly nimble pencil because Mars rotates rapidly, in about 24 hours 37 minutes. If a drawing requires more than 15 minutes, the positions of the markings will be inaccurate. The observer must record with each drawing his name (lest an innocent person be blamed!), his place of observation, the size and type of his telescope, the magnifying power, and the date and time (giving the kind of time used, and al-

Mars in a 33-inch refractor, drawn by E. M. Antoniadi, with the region of Sinus Sabaeus central on the disk. See his chart of the planet on pages 268 and 269.

ways stating the year). He should include the *seeing* or atmospheric steadiness, on a scale of 0 (worthless) to 10 (perfect); the *transparency* or atmospheric clearness, on a scale of 1 (very hazy) to 5 (very clear); and any other remarks helpful in evaluating the observation.

Of course, an observer should *never* try to force his drawing to resemble maps or drawings by others; when he does, its value as an independent record is lost. For instance, Syrtis Major may have been obscured by Martian clouds and have lacked its usual prominence when some particular drawing was made.

There is a second failing to which observers of Mars seem very prone. Do *not* try to identify markings merely from what you think you know of the map of the planet. The proper method is to compute the longitude of the central meridian and then refer to a suitable map. This may prevent you from mistaking Solis Lacus for Syrtis Major. In *The Strolling Astronomer,* July, 1953, pages 96-98, there is an explanation with examples of how to find the longitude of the central meridian from the data in the *American Ephemeris and Nautical Almanac.* The latter gives each year an ephemeris for physical observations of Mars which is an indispensable aid to the serious observer.

Skill in drawing planets must be developed by practice, and the beginning regular observer will be pleasantly surprised by how much his ability to see and draw detail improves with the passing weeks. The same beginner may profitably draw the moon as it looks to the naked eye or in binoculars; and since the aspect of the moon is known very well, he can learn to what errors in drawing he is subject.

The amateur can also make observations of the colors of the different markings. Color filters of *known* transmission, properly used (as explained by James C. Bartlett, Jr., *The Strolling Astronomer,* April, 1953, pages 53-56), can aid in determining what hues are present. If it is desired to study changes in color of Martian markings, seasonal variations for example, then it will be essential to use the *same* telescope with the *same* eyepiece for all observations, and to observe only in a clear and fully dark sky with the planet as high as possible above the horizon. Even then, enough sources of false changes in colors will remain. Reflectors are naturally to be preferred to refractors for studies of colors.

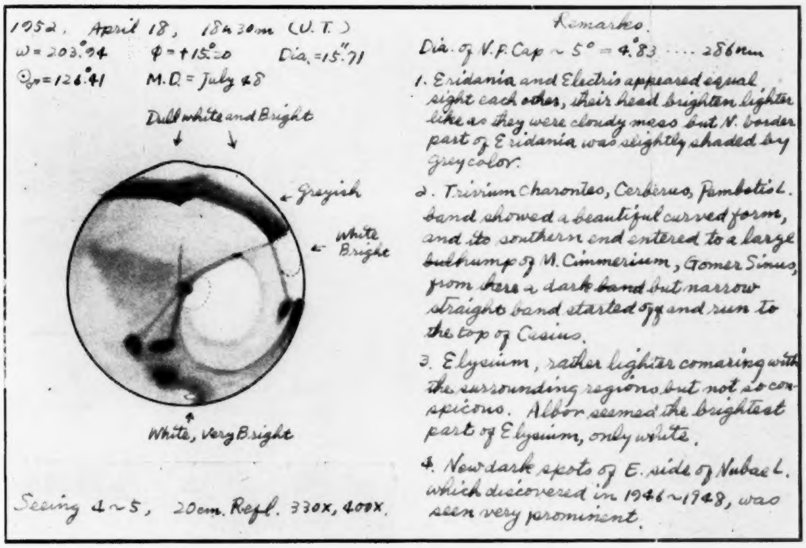
Amateurs may also take photographs of Mars, though an aperture of 10 inches or more is needed to show much detail. E. E. Hare and E. K. White have secured very praiseworthy results enlarging the image of Mars by projecting it through an eyepiece, even at the price of much-increased exposure times. In 1952, Mr. Hare was successful in photographing at least a dozen canals with his 12-inch reflector.

Careful determinations of the Martian longitudes and latitudes of different features are of value. These may be obtained by later measures of drawings or photographs, or at the eyepiece by measurements with a filar micrometer.

Longitudes of Martian features are easily observed telescopically without any accessories. Watch the marking as it is carried across the disk by rotation, and estimate to the minute the time when it passes the line which joins the polar cap with the center of the disk. Then the longitude of the marking is the same as the longitude of the central meridian at that time. To avoid complications from the planet's phase, such observations are best made within a month before or after opposition. Longitude determinations made in this way are usually more accurate than measurements from drawings, and are very useful as a basis for maps of Mars and for checking the rotation period of the planet.

The size of the south cap as it melts away should be very frequently determined, either with the filar micrometer or, less accurately, by simple estimates of its diameter relative to the diameter of the planet.

In studying Martian clouds and their motions, color filters will be found helpful, yellow clouds being brightened with yellow filters and blue clouds with blue filters. When a cloud projects at the edge of the disk, the observer should very carefully note its precise position and appearance and the exact time. He should then make every effort to recover the cloud projection on the next night. If he is successful and if the cloud is in a slightly different position on Mars on the second night, the two observations will permit us to determine the rate of motion of the cloud over the surface.

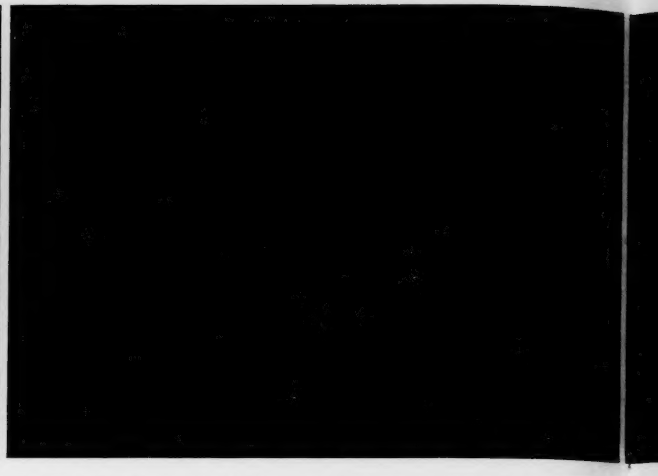


This is report No. 93 to the Association of Lunar and Planetary Observers from Tsuneo Saheki, of Osaka, Japan. It shows his drawing and notes for April 18, 1952, at 18:30 Universal time, with an 8-inch reflector. To make the engraving, the original report has been reduced in a 5:3 ratio.

However, it is difficult to distinguish between true cloud projections and apparent projections caused by the irradiation of bright areas close to the edge of the disk.

For further reading on Mars, the article by Thomas R. Cave, Jr., in the August, 1952, *Sky and Telescope* should be mentioned. The practical observer who desires a description of the Martian surface features can consult an article in the *Journal* of the British Astronomical Association for December, 1953, page 4. Detailed descriptions are given in Antoniadi's book, *La Planète Mars,* Paris, 1930. G. de Vaucouleurs' *The Planet Mars,* London, 1951, is recommended. Current and recent amateur observations of the red planet are collected in *The Strolling Astronomer,* and in the *Memoirs* of the British Astronomical Association.

The Association of Lunar and Planetary Observers will be very glad to receive observations of Mars made by careful amateurs everywhere. These observations should be sent to our Mars recorder, D. P. Avigliano, at 678 W. Manzanita, Sierra Madre, Calif. It will be best if the records are submitted at regular intervals, such as the first of every month. We hope that by such a co-operative study we may make some progress in solving the many riddles of Mars.



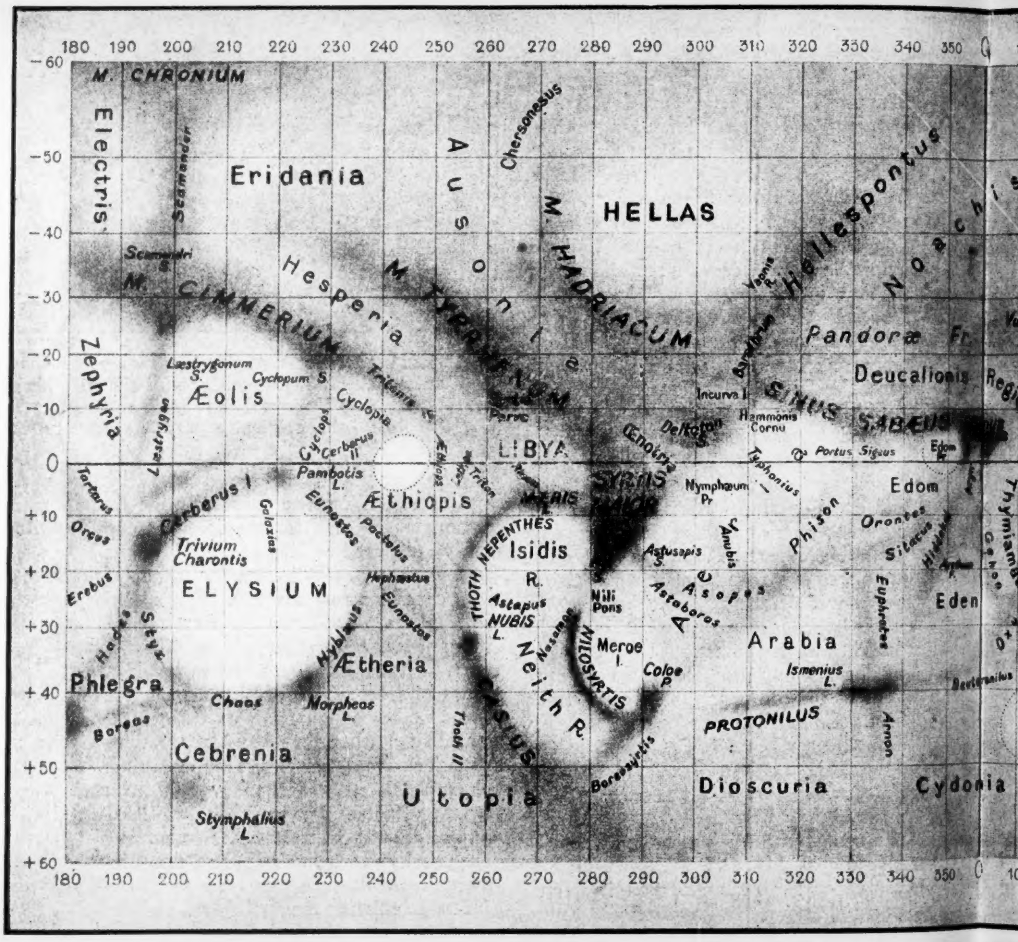
PHOTOGRAPHS OF MARS IN 1941

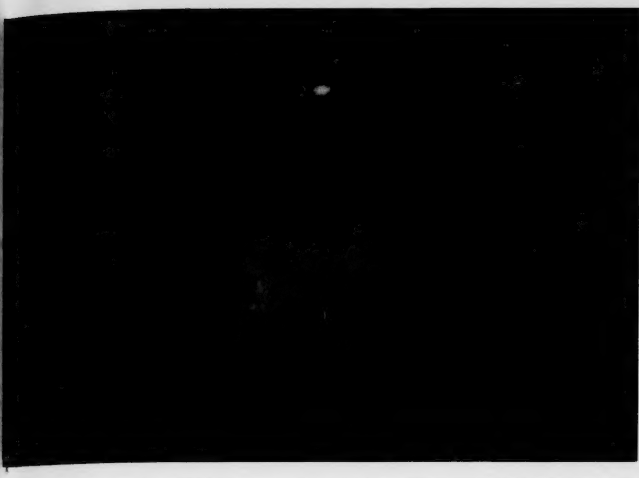
These photographs of Mars, by Bernard Lyot with the 15-inch refractor of the Pic du Midi Observatory, are among the finest ever made of the red planet. The reader can identify the surface features in each picture with the aid of the accompanying map of Mars by E. M. Antoniadi.

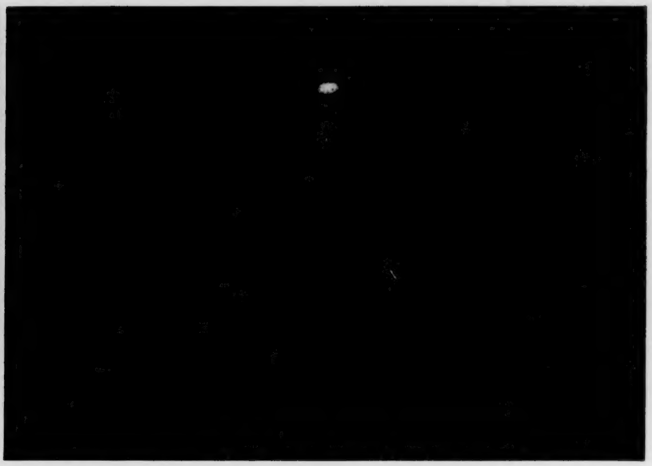
The order in which the photographs are arranged shows the drift from right to left of the dark markings across the disk of the planet, in consequence of the Martian rotation. South is at the top in each case. The date, Universal time, and longitude of the central meridian of Mars for each photograph are:

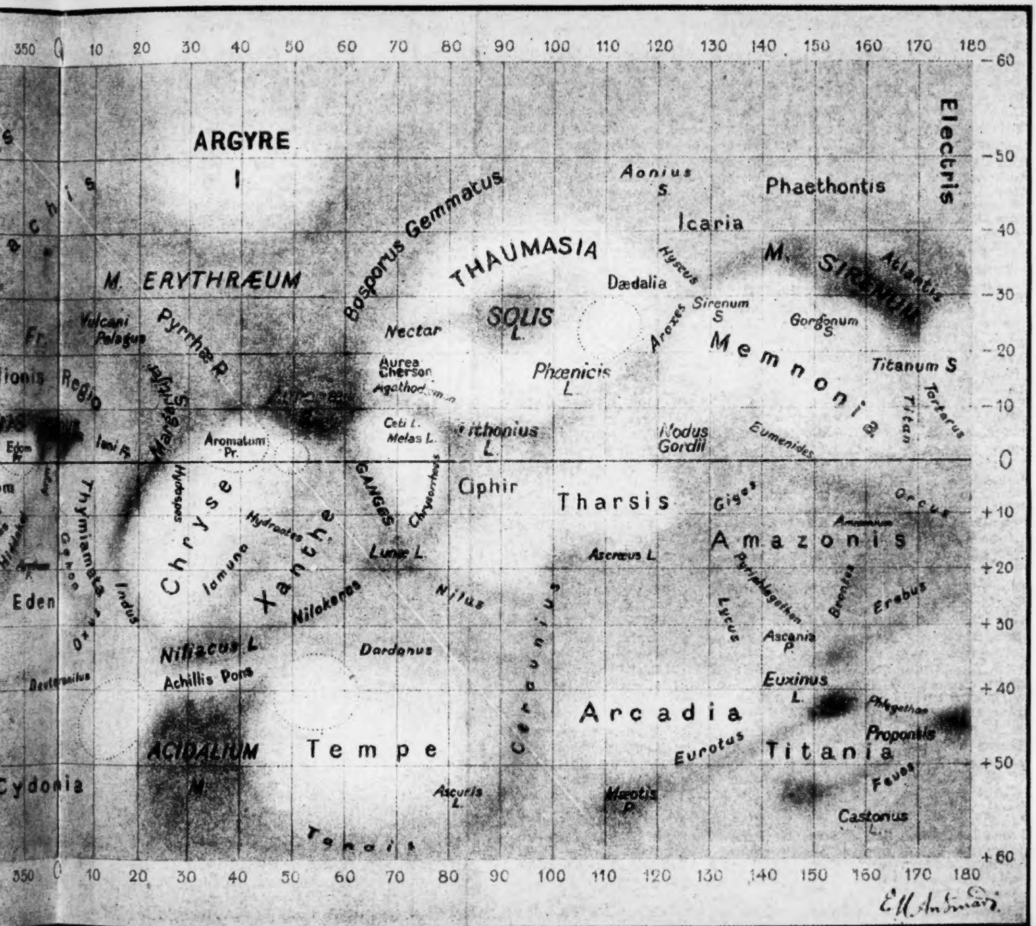
	1941	UT	CM
Above:	Sept. 27	3:33	30°.1
	Sept. 20	1:57	69.3
	Oct. 19	23:20	125.4
	Oct. 15	22:36	151.0
Below:	Oct. 12	22:26	175.0
	Oct. 16	2:20	206.0
	Oct. 8	0:40	251.3
	Oct. 8	3:58	299.3

Note Thoth-Nepenthes, one of the broadest and most conspicuous of the canals, running out from the great dark triangular region, Syrtis Major. These Mars pictures are courtesy of Audouin Dollfus, Meudon Observatory.









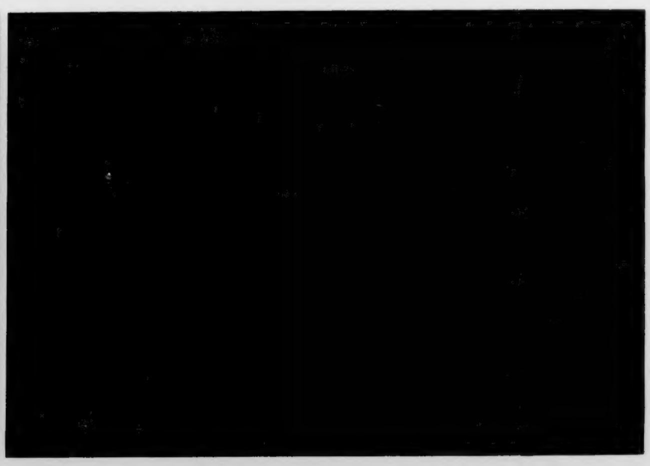
An Antoniadi Map of Mars

This map was drawn by the well-known French student of the planets, E. M. Antoniadi, who died in 1944. He compiled it from the visual observations made during the 1913-1914 opposition by members of the Mars section, British Astronomical Association.

The horizontal scale of the map is areographic longitude, and shows what features will be near the center of the Martian disk when the longitude of the central meridian has the same value. East is to the right, in the direction of increasing longitude; south is at the top. The abbreviations used are: M, Mare; S, Sinus; Fr, Fretum; L, Lacus; P, Palus; F, Fons; R, Regio; and Pr, Promontorium.

At longitude 225°, the canal Cyclops has undergone extraordinary changes. Between the years 1783 and 1800 it was a vast dark area, comparable to Syrtis Major in size and conspicuousness.

The Solis Lacus region, which appears in the second and third pictures in the top row of Lyot photographs, also shows remarkable changes. The engraving printed here has been lent by the British Astronomical Association.



HERE AND THERE WITH AMATEURS

*Members receive *Sky and Telescope* as a privilege of membership. †Member organizations of the Astronomical League.

State	*City*	*Organization*	*Time*	*Meeting Place*	*Communicate With*
ARIZONA	Phoenix	*Phoenix Obs. Ass'n	7:30, 1st, 3rd Tue.	Private homes	R. D. Smith, Jr., 6635 N. Central Ave.
CALIFORNIA	Fresno	*Central Val. Ast'mers	7:45, 2nd Mon.	Fresno Coll., homes	Elizabeth Dean, 409 Shields (4)
	Kentfield	*Marin Am. Ast.	8:00, 4th Fri.	Marin College	V. S. Yoder, 48 Mercury Ave., Mill Valley
	Long Beach	†*Excelsior Tel. Club	7:30, 3rd Fri.	Art Center	T. R. Cave, Jr., 265 Roswell Ave. (3)
	Los Angeles	L.A.A.S.	7:45, 2nd Tue.	Griffith Obs.	G. Carroll, 7114 Summitrose St., Tujunga
	Oakland	*Eastbay A.S.	8:00, 1st Sat.	Chabot Obs.	Mrs. David Roberts, 551 El Dorado Ave. (11)
	Palo Alto	*Peninsula A.S.	7:30, 1st Fri.	Community Center	H. W. Milner, 350 Tennyson Ave.
	Redlands	*Redlands A.S.	7:30, Tues.	Univ. of Redlands	Miss R. Schweikert, 111 Prospect Dr.
	Sacramento	*Sac. Val. A.S.	8:00, 1st Tue., bi-mon.	Sacramento College	Mrs. E. Champ, 3816 Sacramento Blvd. (17)
	San Diego	Ast. Soc. of S.D.	7:30, 1st Wed.	504 Electric Bldg.	W. T. Skilling, 3140 Sixth Ave.
	San Diego	A.T.M. Ast. Club	7:30, 2nd, 4th Mon.	3121 Hawthorn St.	Al Nelson, 3121 Hawthorn St.
	San Francisco	*S.F. Am. Ast'mers	8:00, 1st Wed.	Randall Junior Mus.	H. A. Wallace, 2925A Jackson St.
	Stockton	*Stockton A.S.	8:00, 2nd Mon.	Stockton College, C-3	Dr. C. P. Custer, 155 E. Sonoma Ave.
COLORADO	Denver	†*Denver A.S.	8:00, 2nd, 4th Fri.	Chamberlin Obs.	John Boatright, 1460 S. Clayton, RA-0375
CONNECTICUT	Middletown	*Centr. Conn. A.A.	8:00, 1st Tue.	Van Vleck Obs.	Walter Fellows, Middle Haddam
	New Haven	†A.S. of New Haven	8:00, 4th Sat.	320 York St.	Florence Welter, 77 Spring Rd., N'th Haven
	Norwalk	*Perkin-Elmer AA&TM	5:00, 1st, 3rd Wed.	Perkin-Elmer plant	J. Vrabel, Bob White Lane, Wilton
	So. Norwalk	†Fairfield Co. A.S.	8:00, Alt. Fri.	Private homes	Goldie L. Grantham, 58 Bouton St.
	Stamford	Stam. Museum A.A.	8:00, 3rd Fri.	Stamford Museum	R. F. Ives, Post Rd. East, Darien
DIST. COL.	Washington	†Nat'l. Cap. Ast'mers	8:00, 1st Sat.	Comm. Dept. Audit.	Miss G. Scholz, 110 Schuyler Rd., Sil. Spg., Md.
FLORIDA	Daytona Beach	D. B. Stargazers	8:00, Alt. Mon.	105 N. Halifax Ave.	Wm. T. Thomas, 105 N. Halifax
	Jacksonville	†*J.A.A.C.	8:00, 1st, 3rd Mon.	Private homes	E. L. Rowland, Jr., 442 St. James Bldg.
	Key West	†Key West A.C.	8:00, 1st Wed.	Private homes	J. M. Martin, 1605 United St.
	Miami	†*South'n Cross A.S.	7:30, 3rd Mon.	Central School	A. P. Smith, Jr., 426 S.W. 26 Rd.
	Miami Springs	†*Gulfstream A.A.	8:00, 4th Fri.	Boys Club, 2805 SW32Av.	L. G. Pardue, 641 Falcon, 88-5434
	Patrick AFB	*Banana River A.S.	8:00, 2nd Wed.	Civilian Personnel Bldg.	Lt. R. W. Edelen, Box 669, Patrick AFB
	Pensacola	†Pensacola A.A.C.	7:30, 3rd Mon.	Private homes	Frank Dachille, 1781 E. Baars St.
	St. Petersburg	†St. P'burg A.A.C.	7:30, 4th Thu.	Museum Auditorium	Dr. R. E. Angell, 233 5th Ave. N.
GEORGIA	Atlanta	†*Atlanta A.C.	8:00, 3rd Fri.	Agnes Scott College	W. H. Close, 225 Forkner Dr., Decatur
	Columbus	*Columbus A.A.C.	7:30, 1st Fri.	Bradley Mem. Lib.	Marcia Thompson, 1306-16 Ave.
ILLINOIS	Chicago	†*Burnham A.S.	4:00, 2nd Sun.	Adler Planetarium	J. A. Anderer, 7929 S. Loomis Blvd. (20)
	Galesburg	†*G'burg Am. Ast'mers	7:30, 1st. Wed.	Knox Obs.	H. L. Horein, 1246 N. Morton Ave.
	Geneva	*Fox Valley A.S.	8:00, 1st Tue.	Geneva City Hall	Joseph Zoda, 420 Fellows St.
	Moline	†*Popular A.C.	7:30, Wed.	Sky Ridge Obs.	Carl H. Gamble, 3201 Coaltown Rd.
	Peoria	Ast. Sec., Acad. Sci.	8:00, 2nd Wed.	Peoria Hts. School	R. P. Van Zandt, 156 N. Eleanor Pl. (5)
INDIANA	Indianapolis	†*Indiana A.S.	2:15, 1st Sun.	Riley Library	W. E. Wilkins, 6124 Dewey Ave. (19), IR-5946
	South Bend	*St. Jos. Valley Ast.	7:30, 1st Thu.	YMCA	Bruce A. Lovell, RR 6, Box 61A
KANSAS	Wichita	†*Wichita A.S.	8:00, 1st Wed.	214 East High Sch.	S. S. Whitehead, 425 N. Lorraine (8), 62-6642
KENTUCKY	Louisville	†L'ville A.S.	8:00, 1st Tue.	Univ. of Louisville	B. F. Kubaugh, 207 Sage Rd. (7)
LOUISIANA	Gretna	Gretna A.S.	7:00, Alt. Wed.	Private homes	John A. Gunther, 209 Newton St.
	Lake Charles	†*Lake Charles A.A.C.	7:30, 2nd Thu.	McNeese State Coll.	Norman G. Lore, 532 Alamo St.
	New Orleans	A.S. of N.O.	8:00, Last Wed.	Cunningham Obs.	Dr. J. Adair Lyon, 1210 Broadway
MAINE	Portland	†A.S. of Maine	8:00, 2nd Fri.	Private homes	H. Harris, 27 Victory Ave., S. Portland
MASSACHUSETTS	Cambridge	†*Bond A.C.	8:00, 1st Thu.	Harvard Obs.	R. Smith, 519 Quincy Shore Dr., No. Quincy 71
	Cambridge	†*A.T.M.s of Boston	8:00, 2nd Thu.	Harvard Obs.	John Patterson, 142 Elgin, Newton Center 59
	Cambridge	*M.I.T. A.S.	7:30, Alt. Wed.	Mass. Inst. Tech.	R. L. White, Box 162, 3 Ames St.
	Springfield	†*S'field Stars	8:00, 2nd Wed.	Private homes	J. E. Welch, 107 Low'r B'verly Hills, W. S'field
	Worcester	†*Aldrich A.S.	7:30, 1st, 3rd Tue.	Mus. Natural Hist.	W. C. Lovell, 24 Courtland (2), 3-1559
MICHIGAN	Ann Arbor	†Ann Arbor A.A.A.	7:30, 2nd Mon.	U. of Mich. Obs.	Stewart W. Taylor, 1106 Birk Ave.
	Battle Creek	†B. C. Ast. Club	8:00, 2nd Fri.	Kingman Museum	Mrs. W. V. Eichenlaub, 47 Everett St.
	Detroit	†*Detroit A.S.	2:30, 2nd Sun.	Wayne U., State Hall	E. R. Phelps, Wayne University
	Jackson	Jackson A.S.	7:30, 2nd, 4th Thu.	Public Library	Allen Bell, 1103 Hamlin Pl.
	Kalamazoo	†Kalamazoo A.A.A.	8:00, Sat.	Private homes	Mrs. B. F. Croghan, 216 Burr Oak St. (32)
	Lansing	†*Lansing A.A.	8:00, Fri.	No. 8 Fire Station	Edward H. Carlson, 2111 Grant St. (10)
	Pontiac	†*Pon.-N.W. Det. A.A.	3:00, 3rd Sun.	Cranbrook Inst.	G. Carhart, 40 Hadsell Dr., FE 2-9980
MINNESOTA	Minneapolis	M'polis A.C.	7:30, 1st Wed.	Public Library	Anna Klint, 2526 Garfield Ave. S. (5)
	St. Paul	†*St. Paul Tel. Club	7:30, 2nd, 4th Wed.	Macalester Coll.	Mrs. R. E. English, 1283 Sargent Ave.
MISSOURI	Fayette	†*Central Mo. A.A.	7:30, 3rd Sat.	Morrison Obs.	R. C. Maag, 816½ S. Mass., Sedalia
	Kansas City	†*A.C. of Kans. City	8:00, 4th Sat.	K. C. Museum	Mrs. Laura Kinsey, 4604 Jefferson (2)
	St. Louis	†*St. Louis A.A.S.	8:00, 3rd or 4th Fri.	Inst. of Tech., St. L. U.	S. O'Byrne, 501 E. Pacific, Webster Groves 19
NEVADA	Reno	A.S. of Nev.	8:00, 4th Wed.	Univ. of Nevada	E. W. Harris, University of Nevada
NEW JERSEY	Caldwell	West Essex A.A.	8:00, 2nd Mon.	Caldwell Mun. Bldg.	Donald C. Smith, 19 Francisco Ave.
	Cranford	†*A.A.S. of Union Co.	8:00, 4th Fri.	Girl Scout House	Mrs. W. N. Lurcott, 220 High St.
	Jersey City	†Revere Boys Club	7:15, Mon., Tue.	Gregory Mem. Obs.	Enos F. Jones, 339 Wayne St.
	Rutherford	A.S. of Rutherford	8:00, 1st Thu.	YMCA	W. B. Savary, 78 W. Pierrepont Ave.
	Teaneck	†Bergen Co. A.S.	8:30, 2nd Wed.	Obs., 107 Cranford Pl.	J. M. Stofan, 332 Herrick
NEW MEXICO	Las Cruces	†*A.S. of L.C.	....., 1st Sat.	Private homes	C. W. Tombaugh, 636 S. Alameda
	Roswell	*Pecos Val. S.&T.C.	7:30, 2nd Fri.	Cha. of Comm.	Dr. R.R. Boyce, Rt. 2, Box 163A
NEW YORK	Brooklyn	†Junior A.C.	8:00, 3rd Fri.	Bklyn Public Library	Jr. A.C., Pub. Lib., Grand Army Plaza (38)
	Buffalo	†*Buffalo A.A.	7:30, 1st Wed.	Mus. of Science	Dr.F.S.Jones,83Briarcliffe,Cheektowaga(25)
	Corning	Corning A.C.	8:00, 1st, 3rd Mon.	Corning Glass Center	W. R. Redmond, 119 E. 2nd St.
	Gloversville	†A.C. of Fulton Co.	....., ...	....	L. R. Ogden, 60 W. Pine St.
	New York	*A.A.A.	8:00, 1st Wed.	Amer. Mus. Nat. Hist.	G. V. Plachy, Hayden Plan., TR 3-1300
	Rochester	†Ast. Sec., Acad. Sci.	8:00, 1st Fri.	Rochester Museum	Louise Zeitler, 91 Hickory St. (20)
	Schenectady	†*S'tady A.C.	7:30, 3rd Mon.	Nott Terrace H. S.	C. E. Johnson, 102 State St.
	Troy	*Renss. Ap. Soc.	7:30, Alt. Tue.	Sage Lab., R.P.I.	Dr. Robert Fleischer, R.P.I.
	Utica	†*Utica Am. Ast'mers	7:30, 4th Tue.	Proctor Inst.	John Zimm, 239 Thieme Pl.
	Wantagh	Long Island A.S.	8:00, Sat.	Private homes	A. R. Luechinger, Seaford Ave., 1571
N. CAROLINA	Greensboro	†*Greensboro A.C.	8:00, 2nd Wed.	Woman's Coll., U.N.C.	Mrs. J. Bradshaw, Guilford College, N.C.
	Raleigh	†Astronomical Soc.	....., 1st, 3rd Thu.	N. C. State Coll.	Richard C. Davis, Sch. of Textiles
	Winston-Salem	†*Forsyth A.S.	7:30, Last Fri.	Private homes	Kenneth Shepherd, 1339 W. 4th St.
NORTH DAKOTA	Grand Forks	†*Red River A.C.	8:00, 2nd, 4th Mon.	City Hall	L. G. Peck, 2101 1st Ave. North
OHIO	Akron	*A.C. of Akron	8:00, Last Fri.	St. Peter's Epis. Church	Mrs. R. J. Couts, 878 Kennebec Ave. (5)
	Cincinnati	*Cin. A.A.	8:00, Various days	Cincinnati Obs.	Robert Berkmeier, 2432 Ohio Ave.
	Cincinnati	*Cin. A.S.	8:00, 3rd Wed.	5556 Raceview Ave.	John Dann, 3318 Felicity Dr. (11)
	Cleveland	†Cleveland A.S.	8:00, Fri.	Warner & Swasey Obs.	Mrs. Helen Strohm, Warner & Swasey Obs.
	Columbus	*Columbus A.S.	8:00, 2nd Sat.	McMillin Obs.	Miss R. A. Charlton, 1361 E. 22 Ave. (11)
	Dayton	A.T.M.s of Dayton	Eve., 3rd Sat.	Private homes	F. E. Sutter, RR 7, Box 253A (9)
	Lorain-Elyria	*Black River A.S.	7:30, 1st Wed.	Spang Bldg.	Louis Rick, Box 231, Lorain
	Marietta	Marietta A.S.	Irregular	Cisler Terrace	Miss L. E. Cisler, Cisler Terrace
	Toledo	Toledo Ast. Club	....., 3rd Tue.	Univ. of Toledo Obs.	E. D. Edenburn, 4124 Commonwealth Ave.
	Warren	Mahoning Val. A.S.	8:00, Thu.	Private homes	S. A. Hoynos, 1574 Sheridan, NE, 25034
	Youngstown	*Y'town A.C.	7:30, 1st Fri.	Homestead Pk. Pav'n.	F. W. Hartenstein, 905 Brentwood
OKLAHOMA	Tulsa	†*Tulsa A.S.	7:30, 1st Sat.	Private homes	R. L. Frossard, 4218 E. 25th Ave.
OREGON	Portland	†*Portland A.S.	8:00, Tue.	Journal Bldg.	H. J. Carruthers, 427 S.E. 61 Ave.
	Portland	†A.T.M. & Observers	8:00, 2nd Tue.	Private homes	Miss M. Edgar, 1626 S.E. Nehalem (2)
PENNSYLVANIA	Beaver	†*Beaver Co. A.A.A.	8:00, 4th Tue.	Com'y Bldg., Tamaqui	Mrs. R. T. LuCaric, Box 463, Baden
	Millvale	A.A.A. Shaler T'ship	8:00, 3rd Fri.	Cherry City Fire House	Cliff Raible, Rebecca Sq. (9)
	Philadelphia	†A.A. of F.I.	8:00, 3rd Fri.	Franklin Institute	Edwin F. Bailey, LO 4-3600
	Philadelphia	†*Rittenhouse A.S.	8:00, 2nd Fri.	Franklin Institute	John Streeter, LO 4-3600
	Pittsburgh	†*A.A.A. of P'burgh	8:00, 2nd Fri.	Buhl Planetarium	Mary Burcik, 315 Moore Ave. (10)
	Pottstown	†Pottstown A.A.C.	7:30, Fri.	Public Library	W. E. Schultz, Public Library
RHODE ISLAND	Providence	Skyscrapers, Inc.	8:00, Mon. or Wed.	Ladd Observatory	Ladd Obs., Brown U., Jackson 1-5680

Amateur Astronomers

THIS MONTH'S MEETINGS

Chicago, Ill.: Burnham Astronomical Society, 3:30 p.m., Adler Planetarium. June 13, Dr. G. Van Biesbroeck, Yerkes Observatory, "Eclipses of the Sun."

Dallas, Tex.: Texas Astronomical Society. June 28, 8 p.m., field meet, Dr. McNeill's Log Cabin, 7814 Forney Rd.

Lake Charles, La.: Lake Charles Amateur Astronomers Club, 7:30 p.m., McNeese State College. June 10, W. Laurents, Jr., "Nebulae."

Lorain-Elyria, Ohio: Black River Astronomical Society, 8 p.m., Ely School, Elyria. June 2, A. Schork, "Total Eclipses."

South Bend, Ind.: St. Joseph Valley Astronomical Society, 7:30 p.m., YMCA. June 3, W. G. Fassnacht, "Optics."

Teaneck, N. J.: Bergen County Astronomical Society, 8:30 p.m., Observatory, 107 Cranford Pl. June 9, James Pickering, "Deep Sky Objects."

MINNEAPOLIS JUNIOR GROUP

Under sponsorship of the Science Museum of the Minneapolis Public Library, junior and senior high school students interested in astronomy and telescope making have organized the Junior Astronomy Club of Minneapolis. Business meetings are held at the museum on the second and fourth Wednesdays of each month, and laboratory sessions are conducted there every Friday. Work on a 6-inch reflector and Spitz planetarium demonstrations are included in the program.

Further information about this group can be obtained from its president, Craig L. Shurr, Junior Astronomy Club, Minneapolis Public Library-Science Museum, Minneapolis, Minn.

ECLIPSE PHOTOGRAPH COMPETITION

For amateur observers in the United States and Canada, Sky and Telescope is conducting a competition of eclipse photographs, with prizes of $20, $10, and $5. There is an additional prize of $10 for the best special-interest photograph. Complete details of the competition were published on page 71 of the January, 1954, issue, and on page 200 of the April issue. Entries must reach the office of Sky Publishing Corporation, Harvard College Observatory, Cambridge 38, Mass., not later than Wednesday, July 21, 1954. The winning entries will be published in the September issue.

WEST VIRGINIA SOCIETY

The newly formed Fairmont Amateur Astronomers Association, Inc., sponsored by Fairmont State College, has been holding regular meetings this spring, followed by observing divided into groups for beginners and advanced. We have a membership of 24, and our equipment includes two 3-inch refractors and a 5-inch, and three 6-inch reflectors. An observing party meets on Fridays, and three different observing groups are being developed—deep-space objects and double stars; solar, planetary, and lunar work; and meteors.

Any interested person in the West Virginia area is invited to get in touch with us.

DAVID D. MEISEL, president
800 Eighth St.
Fairmont, W. Va.

WESTERN AMATEURS CONVENTION

The sixth annual convention of the Western Amateur Astronomers will be held in San Francisco on August 27-29, Friday through Sunday, according to the monthly bulletin of the Eastbay Astronomical Society. Further information may be obtained from W. C. Marion, 3511 Lyon Ave., Oakland 1, Calif.

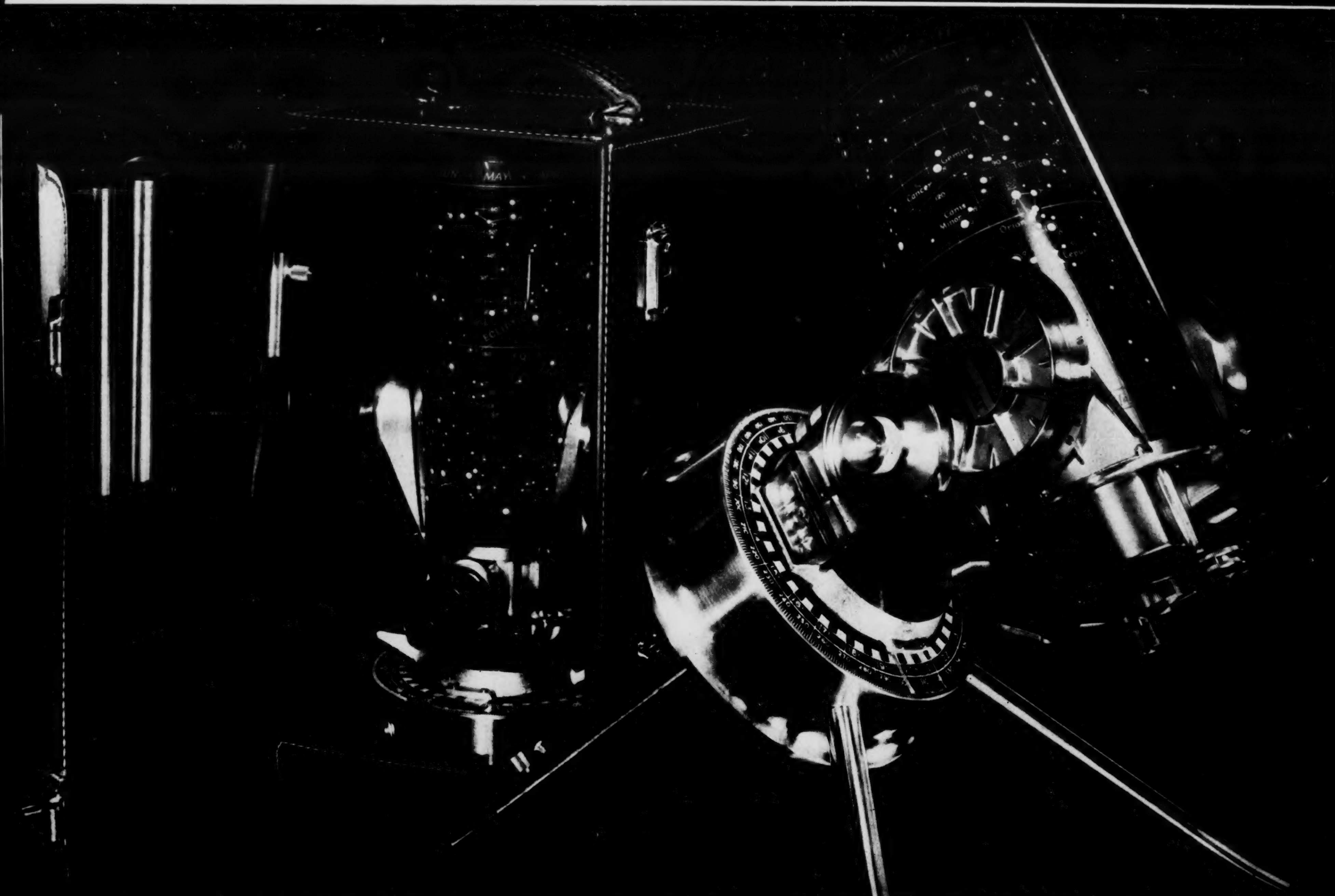
MADISON CONVENTION

The first session of the Astronomical League convention on the University of Wisconsin campus in Madison, July 2-5, will open at 1:30 p.m., under the chairmanship of Rolland R. LaPelle, Meadville, Pa., league president. Chairmen of the other sessions are: **solar observing,** James H. Karle, Portland, Ore.; **planetary observing,** Joseph A. Anderer, Chicago, Ill.; **lunar observing,** Russell C. Maag, Sedalia, Mo.; **junior astronomers,** Clarence E. Johnson, Schenectady, N. Y.; **eclipse reports,** Paul W. Stevens, Rochester, N. Y.; **instruments,** Thomas R. Cave, Jr., Long Beach, Calif.

All sessions of the convention are open to the public, and everyone who has come to the region to view the June 30th eclipse is invited to attend. Further information on the convention should be requested from Mrs. Harold B. Porterfield, 1001 University Bay Dr., Madison 5, Wis.

HERE AND THERE WITH AMATEURS (*continued*)

State	*City*	*Organization*	*Time*	*Meeting Place*	*Communicate With*
TENNESSEE	Chattanooga	†*Barnard A.S.	8:00, 3rd Fri.	Jones Observatory	A. H. Jones, 411 W. 21st St., 5-1646
	Memphis	†Memphis A.S.	8:00, 1st Fri.	Memphis Museum	J. M. Buhler, 3796 Central Ave.
	Nashville	*Barnard A.S.	7:30, 2nd Thu.	Dyer Observatory	Miss J. Saffer, 446 Humphrey St. (10)
TEXAS	Austin	*Forty Acres A.C.	7:30, 2nd Tue.	U. of Tex., Physics Bldg	Forty Acres A.C., Box 7994, Univ. Sta.
	Dallas	†Texas A.S.	8:00, 4th Mon.	Various auditoriums	E. M. Brewer, 5218 Morningside, U-6-3894
	Ft. Worth	†*Ft. Worth A.S.	8:00, 4th Fri.	Texas Christian U.	James M. McMillen, 604 Tierney Rd. (3)
	Port Arthur	†*Port Arthur A.C.	7:30, 2nd Thu.	5228 Fifth St.	F. T. Newton, 5213 Fifth St., 2-4807
UTAH	Salt Lake City	†*A.S. of Utah	8:00, 2nd Fri.	City and County Bldg.	James W. Geertsen, 1197 Whitlock Ave.
VERMONT	Springfield	†Springfield T.M.s	6:00, 1st Sat.	Stellafane	John W. Lovely, 27 Pearl St., 535-W
VIRGINIA	Harrisonburg	Astral Society	7:30, 3rd Thu.	Vesper Heights Obs.	M. T. Brackbill, Eastern Mennonite College
	Norfolk	†*Norfolk A.S.	8:00, 2nd, 4th Thu.	Museum of Arts	A. Hustead, U.S. Weather Bureau, 21745
	Richmond	†*Richmond A.S.	8:00, 1st Tue.	Builders Exchange	J. S. Stith, 3125 Lamb Ave. (22)
WASHINGTON	Seattle	†*Seattle A.A.S.	8:00, 2nd Fri.	YMCA, 5003-12 Ave. N.E.	Louise Crowley, 4727-16 Ave. N.E. (5)
	Spokane	†*A.T.M.s of Spokane	8:00, Last Fri.	Private homes	Mrs. E. Mortensen, W. 1519 Augusta Ave.
	Tacoma	Tacoma A.A.	8:00, 1st Mon.	Coll. of Puget Sd.	Dorothy E. Nicholson, 2816 N. Union Ave
	Yakima	†*Yak. Am. Ast'mers	8:00, 2nd Mon.	Cha. of Comm. Bldg.	Edward J. Newman, 324 W. Yakima Ave.
WISCONSIN	Beloit	†*Beloit A.S.	7:30, 2nd. 4th Wed.	YMCA Bldg.	K. E. Patterson, 318 Public Service Bldg.
	Madison	†Madison A.S.	8:00, 2nd Wed.	Washburn Obs.	Dr. C. M. Huffer, Washburn Obs.
	Milwaukee	†*Milw. A.S.	8:00, 2nd Mon.	Public Museum	E. A. Halbach, 2971 S. 52 St. (15)



Questar is a beautiful and compact 20th-century telescope of

like color of the engraved enamel-filled perpetual star chart, but it does indicate Questar's honest engine-

steady image of a massive observatory telescope, yet weighs but 7 pounds. Smooth automatic following

BOOKS AND THE SKY

CONQUEST OF THE MOON

Wernher von Braun, Fred L. Whipple, Willy Ley. The Viking Press, New York, 1953. 126 pages. $4.50.

ON DECEMBER 17, 1903, the Wright brothers succeeded for the first time in history in traveling through the lower atmosphere of our planet in a powered, heavier-than-air vehicle. The world was then just over the brink of the 20th century, which was to witness a phenomenal acceleration of scientific knowledge. Only four newspapers in the country regarded the event as newsworthy, two of them putting the item somewhere on the inside pages. Little did anyone suspect what an impact powered flight would have on civilization, nor could anyone realize how other amazing inventions and discoveries would within a few decades revolutionize industry, the life of the ordinary man and even his philosophy.

Just past mid-century we find ourselves facing a new era in scientific development and exploration. High-speed electronic calculators now solve complex problems; servo-mechanisms allow the automatic performance of many tasks requiring bull's-eye accuracy; new regions of the electromagnetic spectrum are in use for FM reception, television, microwave spectroscopy, and radio astronomy; and some of the fearsome secrets of the atom have been pried open, offering visions of an age of comfort and leisure. And now the ancient yearning to conquer interplanetary space seems on the verge of fulfillment.

In **Conquest of the Moon** we have a thorough blueprint including almost microscopic detail about the first trip men will take to our nearest neighbor in the solar system. It is written with such authoritative realism that the reader may sometimes get the feeling that he is being informed about a **fait accompli,** rather than about a speculative, futuristic trip to the moon.

Previously, in **Across the Space Frontier,** the authors, collaborating with other scientists, dealt with the establishment of an artificial satellite of the earth to serve the military interests of this country, and to be as well an extraterrestrial laboratory for astronomers, meteorologists, and physicists. Both books are elaborations of symposiums sponsored by **Collier's** magazine. The joint efforts of the authors, each a recognized expert in his own field, have been skillfully edited by Cornelius Ryan.

The highly factual account is illustrated with vivid paintings by Chesley Bonestell, who has become well known for his accurate and imaginative representations of astronomical and space travel subjects. Artists Fred Freeman and Rolf Klep have contributed clear pictures; the realistic space and lunar scenes, as well as the greatly detailed cutaway drawings of spaceships, the personnel spheres for the space travelers, and the lunar base, make the entire description more credible and interesting.

We are introduced first to the space station, circling the earth in a two-hour orbit at a mean distance of 1,075 miles from the earth's surface, which is to serve as the base for the lunar trip. It turns out to be far more practical and economical to start the voyage from the earth's proposed artificial satellite than from the earth's surface, for in the latter instance the rocket ship would have to be taller than the Empire State building and weigh about as much as 10 **Queen Mary**'s!

Before the actual trip is made, a preliminary, exploratory rocket will have been sent to within 50 miles of the lunar surface to photograph in detail its main features. It is proposed that the landing site for the first visitors will be in Sinus Roris, some 200 miles from the crater Harpalus "as the rocket flies," to the northeast of Mare Imbrium and some 1,000 miles north of the lunar equator (the book says 650 miles). There the terrain is flat enough for landing but has crevices in which the lunar headquarters can be set up safe from the dangerous meteorites constantly striking the surface.

No sightseers will be permitted on this first voyage to the moon. Its 50 members

will all be specialized scientists (mineralogist, radiometrist, magnetometrist, microscopist, seismographer, ballistician, astrophysicist) and highly skilled technicians. They will be as well-prepared for their respective tasks as well-prepared observers at a solar eclipse, for all their work must be completed within a month and a half.

Our space travelers will have made the trip with no luxurious accommodations but in cramped quarters like those of a submarine. They must be able to endure great inertial forces at take-off and while braking their forward speed prior to landing. During most of the travel time, they will exist in a practically gravitation-free environment requiring new modes of living. Thus food, pre-cut to bite size, will be prepared in mess kits with spring-operated covers and will be eaten with tong-like devices. Since drinking on the earth depends on gravitation, it will be necessary to serve liquids in plastic containers so that the liquids can be introduced into the mouth by squeezing.

There is no time to study the majestic scenery after landing, for all equipment must be unloaded and the lunar base built at top speed, in not more than 48 hours. Then will come exploration of the lunar surface in the neighborhood of the base. It should be possible to answer some of the age-old questions concerning the volcanic or meteoritic origin of craters, the extent and composition of a lunar atmosphere, the existence of a lunar magnetic field, the nature of the surface. Geophysicists will study the moon's internal constitution by recording distant blasts on sensitive seismographs. Physicists may learn a great deal about the origin of cosmic rays. Astronomers will record the frequency and sizes of meteorite falls.

A lunar day of two weeks will pass, and near the end of lunar night another half-month later, a team of 10 men, including geologists and an astronomer, will board two tractor-driven trailers to explore the crater Harpalus 200 miles away over the rough surface from the base camp. The round trip will take about 10 days, the exploration of the crater walls and floor being among the most exciting and dangerous tasks of the mission. After returning to the base, final preparations will be made for the journey back to the space station and thence home.

The story is told with contagious enthusiasm. The unbounded optimism of its authors is best described in their own words:

"Of course, a lunar expedition is a vast project that will require tremendous planning, but it can be accomplished in the next twenty-five years—providing we begin work **now.** There are no problems involved to which we don't have the answers—or the ability to find them—today."

Conquest of the Moon is the sort of book that can be reread many times, each perusal bringing out interesting details that somehow eluded one before.

MORRIS S. DAVIS
University of North Carolina

THE RISE OF THE NEW PHYSICS

A. d'Abro. Dover Publications, New York, 1953. 983 pages, 2 vol. $7.00, cloth; $3.90, paper.

FORMERLY titled **The Decline of Mechanism,** this reprint is a scholarly yet eminently readable account of the evolution of physical theories from the time of Newton to about 1930, with special emphasis on quantum mechanics.

The first volume is in two parts. Part I deals in a general way with the nature and significance of physical science. It is a collection of penetrating little essays: "Assumptions in Science," "The Significance of Theoretical Physics," "Two Kinds of Simplicity," "Psychological Differences among Physicists," and others. The author makes his points clearly and elegantly, illuminating them with apt historical examples and quotations from mathematicians and physical scientists. These essays add up to a kind of pragmatic natural philosophy that will, I suspect, appeal more to physical scientists than to most philosophers of science.

Part II opens with a hundred pages on pure mathematics. Mathematics is the language of theoretical physics, so that this section furnishes the nonmathematical reader with some of the rudiments of its vocabulary and grammar. As a bonus, the author includes a chapter on the famous controversy between the formalists and the intuitionists on the foundations of mathematics.

Classical physics is the theme of the remainder of Part II. Here d'Abro is concerned mainly with paving the way for an understanding of quantum mechanics. The topics along this way include analytical mechanics, the wave theory of

light, the mathematical analogy between mechanics and geometrical optics, and a remarkably clear elementary exposition of wave mechanics. Finally, there is a chapter on thermodynamics and one on statistical mechanics, where Loschmidt's paradox is very lucidly discussed.

The whole of the second volume, running to well over 500 pages, is devoted to quantum physics, with the exception of some introductory remarks on special relativity. The first hundred pages, dealing chiefly with Planck's law of radiation, pre-quantum atomic physics, and the Bohr atom, provide an introduction to modern quantum theory.

But the remainder of the book is less successful, in my opinion. The early work of de Broglie is described at great length, and many pages are devoted to matrices, matrix mechanics, and to the connection between matrix mechanics and wave mechanics. Yet no clear physical scheme emerges. The difficulty arises largely from the limitations of semipopular scientific writing. The essential features of quantum mechanics are most simply expressed mathematically, in terms of the theory of infinitely dimensional vector spaces. Whether a semipopular exposition along these lines is possible is at least questionable.

On the whole, **The Rise of the New Physics** is a stimulating and rewarding book. It sets a high standard for this kind of writing.

DAVID LAYZER
Harvard Observatory

FLIGHT INTO SPACE

Jonathan Norton Leonard. Random House, New York, 1953. 307 pages. $3.50.

THE LAST few years have seen the clear emergence of space travel as a topic of sober, even refined, speculation, to the huge relief of thousands of people, including many readers of **Sky and Telescope,** who have been fascinated by it all along.

This change was not caused by a spontaneous blossoming of long-fettered imaginations. Rather, it came from the fierce drive of cold-war necessity to develop guided missiles. Though largely hidden in cloak-and-jet mystery, the scope of this development is such that the first rocket to the moon may come in 20 years. Therefore, one need not join chorus with the interplanetary evangelists to predict that an earth-circling "minimum rocket" may prove to be the end-product of the current activity.

Now that you don't have to burn your high school diploma to picture a man-made satellite, "an American star rising in the West," you might want to find a book with the science reasonably well separated from the fiction. Such is **Flight into Space,** by Jonathan Norton Leonard, science editor of **Time,** and happier reading would be hard to find.

Mr. Leonard is a reporter, and would be the first to allow that he is not an authority on any special phase of the subject, such as rocket fuels or the surface conditions of the planets. This is all to the reader's advantage, since it means that no undue time is devoted to ridiculing the more preposterous ideas. The fact that

a theory has been expounded is deemed worth reporting. A spritely manner of writing with tongue firmly rammed into cheek leaves no doubt as to the author's private preference for scheduled airline travel.

In other words, you get your flight into space with the well-known **Time** magazine sophistication while remaining within the letter, if not always the spirit, of scientific orthodoxy. For all the humor, which sets this book apart from every other, the development is logical, going from current successes in rocket research to more ambitious plans and ending with enough imagination to satisfy those who dream of space travel for psychiatric reasons. Even before Leonard gets his first V-2 off the ground he has rewarded the reader with such prose pageantry as this:

"The attendants pump the rocket full of fuel, quiz its electronic brain, probe its valves with sensitive instruments. They are like midget masseurs grooming a tall and graceful ballerina for her first and last appearance on the stage of a great auditorium."

This is out of the chapter headed "Sacrifice at White Sands," which makes it clear that the author has seen as much of these things as any science reporter in the country. He recognizes when he passes over into the realm of the unknown; some unsuspecting readers may fail to make all of the turns, however, for the curves are sharp.

Written with great effect, the problems of going to the moon and on to the planets are vividly stated, but the challenge and the rewards are also pictured. Some risky and once in a while downright wrong astronomy appears from here on, but no earnest **Sky and Telescope** reader is likely to be led astray.

The last 60 pages of the book go far "Into the Black Yonder," leading the imagination in paths that never will be trod. But contact with reality is not entirely lost, in the sense that real people on the earth today are devoting intellectual energies to these imaginings.

Mr. Leonard has himself seen enough of scientific progress to be reluctant to deny "that space flight is inevitable and that it is the next great step in human evolution. If it does not come in ten years, then it will come in fifty or one hundred years. The human race has only begun to feel the thrill of its power."

JOHN W. STREETER
Fels Planetarium

NEW BOOKS RECEIVED

NEUTRON OPTICS, *D. J. Hughes*, 1954, *Interscience Publishers*. 136 pages. $2.50, paper.

This survey, intended for readers with some background in modern physics, treats from an experimental viewpoint the principles of neutron optics, scattering of neutrons by atomic nuclei and by magnetic fields, and diffraction of neutrons by crystals.

Dr. Hughes' book is the first of a new series, Interscience Tracts on Physics and Astronomy. Some other titles of astronomical interest that are in preparation are: W. Baade, *Galaxies and Their Stellar Populations;* L. Goldberg, *Solar Physics;* and J. L. Greenstein, *Radio Astronomy.*

A HISTORY OF THE THEORIES OF AETHER AND ELECTRICITY, 1900-1926, *Sir Edmund Whittaker*, 1954, *Philosophical Library*. 319 pages. $8.75.

This is a sequel to *A History of the Theories of Aether and Electricity, The Classical Theories*, which appeared in 1951 and was reviewed in the January, 1952, issue of this magazine. It is a systematic history of theoretical physics from the period of Rutherford, through Planck's radiation theory, relativity, and quantum mechanics up to the beginnings of wave mechanics.

DIE STERNE DUERFET IHR VERSCHWENDEN, *Helmut Werner*, 1953, *Verlag Gustav Fischer*, Eberhardstrasse 10, Stuttgart, Germany. 180 pages. DM 19.00.

Planetariums throughout the world are the subject of this profusely illustrated book (in German) by Dr. Werner, who has worked with Zeiss planetariums for over two decades. There are numerous photographs and descriptions of special-effects devices, and a listing and pictures of many major planetarium installations. The book is directed to the operator and the patron of the planetarium.

OCCASIONAL NOTES, No. 15, 1953, *Royal Astronomical Society*, Burlington House, London W. 1. 27 pages. 3 shillings.

Appearing at irregular intervals, this series has contained survey articles on a wide range of astronomical and occasionally geophysical topics. In recent years, subjects have ranged from Copernicus to rockets. The present issue has a timely article by J. de Graaff-Hunter on the heights and names of Mt. Everest and other Himalayan peaks. The most reliable figure now available for the height of Everest above sea level is given as 29,079 feet. Ernest Tillotson, in a second article, summarizes modern findings and theories on the constitution of the earth's crust.

GLEANINGS FOR ATM's

EDITED BY EARLE B. BROWN

A Question and Answer and Other Notes

Q. How is an 8-inch f/8 reflector set up for photography and where does one obtain the necessary equipment?—Michael Morrow, 17 Crescent Hill Dr., Havertown, Pa.

A. For photography of star fields, nebulae, clusters, or planets, the telescope should be equatorially mounted and have a driving mechanism. If your instrument is not clock-driven, the exposures must be so short to avoid trailed images that probably the sun and moon would be the only satisfactory astronomical subjects.

The telescope may be adapted in two ways, one to secure photographs at the prime focus (after reflection by the diagonal), the other to obtain an enlarged image projected by the eyepiece. Such parts as camera backs and plateholders are available at camera stores.

In the first case the eyepiece assembly is removed, and a small box is built on the side of the tube in such a way that film or photographic plate may be set in the primary focal plane. With this arrangement, the images are small, but they should be as sharp as the definition of the mirror and observing conditions will allow.

In the second case, which is very desirable where the small images of planets are concerned, an enlarged field is projected to any desired distance from the eyepiece. Here again a box arrangement is required, which may be obtained by using the box and bellows of an ordinary camera. For most celestial work, the lens and shutter of an ordinary camera are not necessary, and these may be removed. For solar photography, however, the entire camera (preferably of the Graflex type) may be used, mounted separately from the telescope, with the aperture of the telescope stopped down and with appropriate neutral-density filters. The camera, which should have a very high shutter speed, is focused for infinity.

When the box is used, with or without the eyepiece, it can be easily prepared to take a camera back, either that kind which holds a double plateholder for glass plates or the kind that will take a film pack, for cut film. It is an advantage if the arrangement permits the insertion of a ground glass for procuring perfect focus before the picture is actually taken. Faint images will show better through ground glass coated with glycerin.

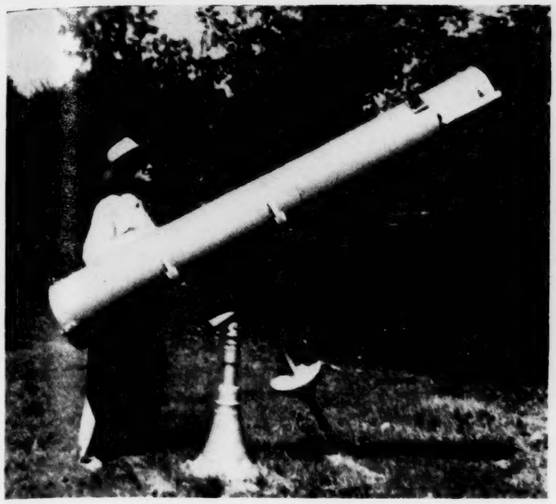
GROOVING A PITCH LAP

ONE of the less tidy aspects of mirror making has always been shaping the pitch lap. The new fast-polishing pitches give laps which are brittle and harder to trim and channel than the older pitches. Nevertheless, the gain in polishing speed is worth the extra effort in preparing the lap.

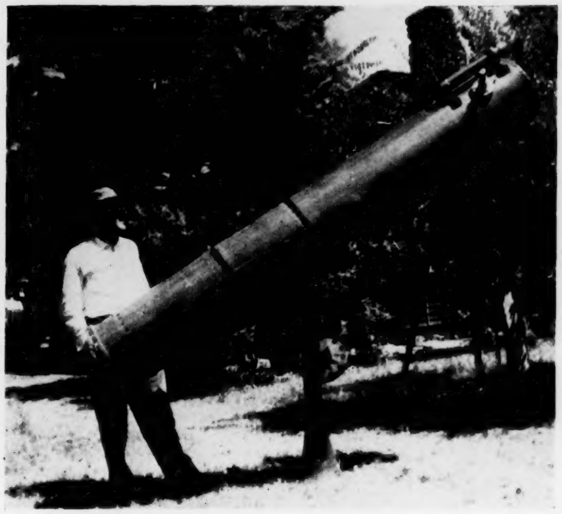
These hard pitches can be easily channeled by using a coarse saw instead of the conventional heated knife. The pitch is sufficiently brittle for the saw teeth to cut rapidly and cleanly into the lap, provided the chips are brushed out after every few strokes of the saw.

This procedure was tested on a typical fast pitch lap, which had been shaped to conform to the workpiece and then allowed to cool. I found that the channels could be cut easily and accurately with a coarse keyhole-type handsaw. The rather thick blade of the keyhole saw gives a cleaner cut than thinner-bladed saws. Only five minutes were needed to channel the lap. Heated knives and other conventional methods of cutting channels are slower, more difficult to control, and usually distort the lap.

I have found that a coarse file is excellent to round the lap, trim off overhang-



The metal tube of B. L. Harrell's 12-inch reflector was made by C. C. Pinckney, of Birmingham, Ala. The mirror is of plate glass, and has a focal length of 86 inches.



The wooden tube of J. L. Hoffman's 12½-inch reflector was made by Henry Stevens. The pyrex mirror, focal length 102½ inches, was made by Leon Watson.

ing or protruding sections, or adjust local irregularities. With either file or saw, a light stroke is best, and the cutting tool should be rubbed clean with a rag after every few strokes. When the lap is completed, the tools are cleaned with a kerosene-wet rag.

WAYNE PROELL
10630 S. St. Louis Ave.
Chicago 43, Ill.

ALABAMA REFLECTORS

SO FAR as I know, the two telescopes described here are the largest in Alabama. An account of them will encourage any one who thinks that it takes a lot of money to build a fair-sized telescope and mounting.

Leon Watson, of Gadsden, Ala., has built a 12½-inch reflector of 102½ inches focal length. Its wooden tube is made of 27 strips of wood put together with nails and casein glue by a pattern maker. The base of the mirror cell is a ribbed aluminum disk about ⅜" thick, originally used in a cream separator.

My own telescope is a 12-inch Newtonian with 86-inch focal length. The tube is fastened in its wooden cradle, made from a board 18" long and 2" thick, by two metal straps which were broken mainsprings from eight-day clocks. Each strap has the short end of a trunk latch riveted to it, and the other part of the latch is screwed to the cradle. This makes it quick and easy to assemble or take down the telescope.

The bases of both telescopes are rearaxle housings, 18" in diameter, from a Fordson tractor. They are from an old model, and so were given to us free.

The adjustable supporting rack here carries a 10-inch mirror.

My mirror was ground and polished on a simple but effective home-made rig. Apart from a motor which cost five dollars a few years ago, the outfit would not cost more than 10 dollars to build.

For testing I used the Ronchi and knife-edge setup described by H. H. Mason in **Amateur Telescope Making.**

To secure a rigid base for this I built a table with three 4″ x 4″ wooden legs. The stand for the mirror during testing gives a three-point support to the mirror which proved always steady. So that mirrors of different sizes can be tested, the board which carries the supports is adjustable by having it sit on two long iron rods, as shown in the picture. In this way the center of the mirror can be raised or lowered to the same height as the light source.

In building my telescope I found that junk yards and scrap piles are wonderful places to find cheap parts that can be adapted with a little work.

B. L. HARRELL
411 S. Fourth St.
Gadsden, Ala.

A SKELETON TUBE FOR A 6-INCH REFLECTOR

THE FIRST TELESCOPE I constructed was a 3¼-inch refractor, but to obtain a more powerful instrument, a 6-inch Newtonian reflector was decided upon. Since my interests were mainly mechanical, the mirror itself was made professionally. Originally, it was planned to use a tube of rolled sheet steel welded at the seam, but it proved too difficult to get one that was perfectly round and straight.

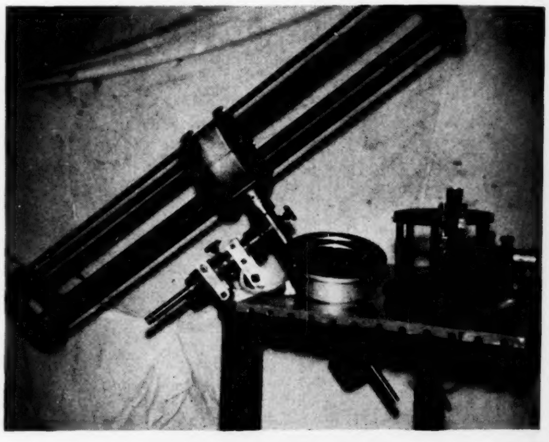
Instead, a skeleton tube was adopted, made in sections that are connected by interlocking concentric aluminum rings. The central section is a 4½″ length of 8″ steel pipe, attached to the end of the declination axis. The rings are held by six ⅝″ aluminum rods pressed into pocketed seats. The ends of these rods are tapped for draw-in screws. This gives a perfectly straight tube, so rigid that no diagonal bracing is needed. The sections are easily disconnected, and can be reassembled in perfect alignment.

The mirror rests on a ⅛″ sponge rubber bottom in a cork-lined cell. This in turn rests on a 7/16″ steel ball bearing centered in the cell housing, which allows ready adjustment for tilt. The housing can be removed from the telescope for transportation or safe keeping by taking out three thumb screws, and can be replaced without readjusting the mirror. The eyepiece and diagonal assembly, which is attached to the upper ring by three thumb screws, can be turned through 360 degrees and locked in any convenient position.

The ball-bearing equatorial head is supported by a 4″ steel standpipe, with four 1″ radial pipe legs. These are pivoted, and the suspended weight acts to lock the legs to the standpipe. This provides a very rigid mounting, and there is no interference with the mirror end of the telescope when it is pointed high in the sky or swung past the meridian.

Like many amateur jobs this one shows its pedigree, but it incorporates some good design features. I would be glad to give more detailed information to anyone desiring it.

N. H. SOOY
424 W. Gregory Blvd.
Kansas City 14, Mo.



The rigid skeleton tube of Mr. Sooy's 6-inch reflector is symmetrical in design. The primary mirror and the cage for diagonal and eyepiece holders are here shown removed. They may be easily replaced on the tube, in perfect alignment.

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A Handsome High Power Scope can be easily built with these parts

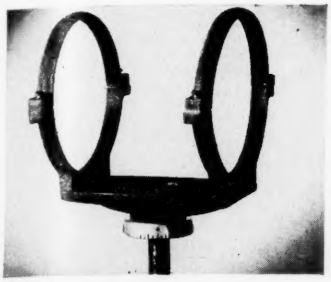
Send for additional information on other items with further details on all parts listed here. Other types of diagonal holders — polaroid unit — filters — zenith 90° mounting.

ELLIPTICAL PYREX DIAGONALS
Flat to 1/8 wave, aluminized
ELLIPTICAL QUARTZ DIAGONALS
Send for Free Bulletin on these items

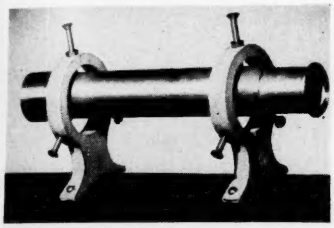
RL-2 MIRROR KIT

Ready to assemble — complete brainwork. Aluminized mirror and diagonal; 3 separate eye lenses; aluminum eye-lens cell; 8 fiber eyepiece retaining rings to make several different powers. Mirror and optical components are 1/4-wave surface accuracy.

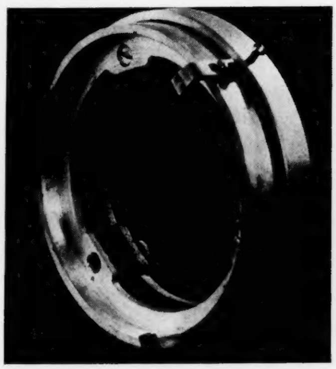
10" Pyrex	$130.00
8" Pyrex	103.00
6" Pyrex	19.00
5" Plate Glass	13.00
4" Plate Glass	10.00
3" Plate Glass	6.25



SADDLE — Unit A and B: 5 cast aluminum parts. Aluminum rings for tubes 1" larger than mirror; sets for 5" and 6" mirrors. Sand-blast finish $14.95



FS — 7X FINDER SCOPE KIT: Corrected 35-mm. large objective; 2 eyepieces; lens holder; eyepiece cell; 9" long tube. Objective is mounted — just assemble eyeset $8.00
MOUNTING RINGS — Unit E: Screws, nuts, etc. Set of 2 .... $5.00



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TUBES — RHINO BOARD: Black in and out; 1/4" non-heat radiation. Two pieces, one piece fits into the other; no mistake can be made on the focal length — just slide in or out and secure. Can be used for permanent or portable unit. Diameter 1" larger than mirror:

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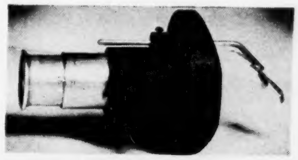
4" tube (3" mirror)	2.00



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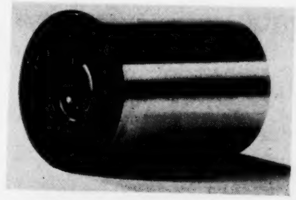

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OBSERVER'S PAGE

Universal time is used unless otherwise noted.

An Introduction to Observing Saturn — II

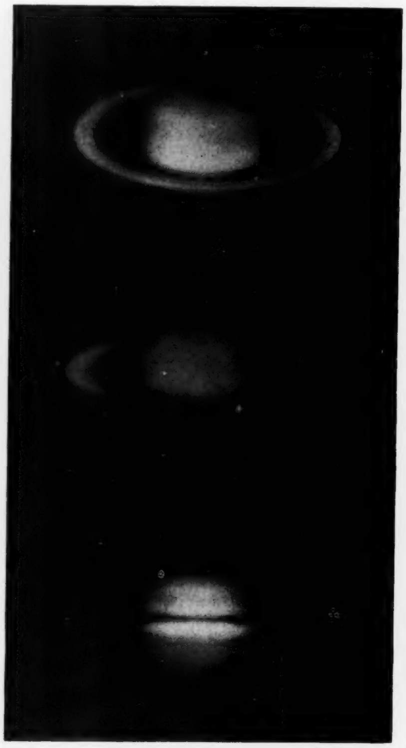
THE RING SYSTEM, through a 6- to 12-inch telescope, will be seen triple. The outer ring A is separated from the middle ring B by Cassini's division. This very dark gap is prominent in any satisfactory view of the planet. The brightest part of the ring system is the outer portion of ring B, whose inner part usually appears gradually shaded in tone until it meets the inner ring C, the crape ring. This inner ring is transparent, for the limb of Saturn can readily be seen through it. Before the date of opposition, the very dark shadow of the globe may be seen on the western side of the ring; after opposition, on the eastern side. The outline of the shadow on the rings has been observed to be irregular by some observers in the past, particularly when the rings were well opened up. On the rings next to this shadow a very bright area, known as the Terby white spot, is sometimes observed; this is an illusion caused by contrast.

These more prominent features can usually be noted, but the advanced observer is more interested in the difficult and delicate details now to be described. There is hardly a greater thrill for the student of Saturn than the detection of one or more of the minor divisions of the ring system. Apart from the prominent Cassini division, undoubtedly the easiest to see in amateur telescopes is Encke's division, located near the middle of ring A. I had a good view of this at the 1953 apparition of Saturn as a very fine dark line, extending nearly completely along the narrower portion of ring A in front of the planet. On this occasion I also noted the rarely seen brighter inner portion of ring A. This observation was made with an 8-inch reflector in excellent seeing.

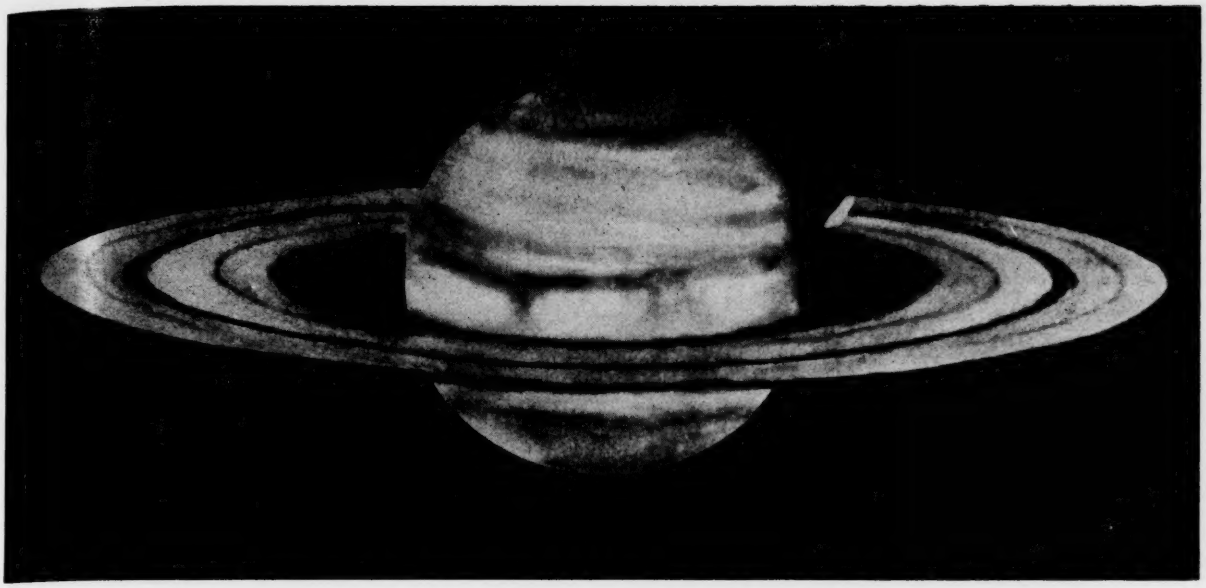
Two minor divisions in ring B that have been detected by amateurs warrant mention. At the inner edge of the bright outside portion of ring B is a shaded zone, which is bounded on the outside by the fourth division, and on the inside by the third division. Inside this is another darker shading. Many times these two concentric shadings may be seen on ring B while the divisions themselves are not detected.

The fifth division is located between rings B and C. Finally, the sixth division is near the middle of ring C. This terminology is that used by the Association of Lunar and Planetary Observers, whose director, Walter H. Haas, discovered the fourth division in the rings in 1942.

Skillful observers have recognized some of these minor features with excellent telescopes as small as a 6-inch, but a somewhat larger instrument is preferable. With the 12-inch refractor of the Griffith Observatory on April 23, 1949, Thomas R. Cave, Jr., and Thomas A. Cragg saw all six divisions, as well as much detail



These photographs of Saturn, taken by H. Camichel at the Pic du Midi Observatory with a 60-cm. telescope, depict the changes in Saturn's appearance as the orientation of its rings changes. The thinness of the rings is evident. From top to bottom, the pictures were taken on February 11, 1946, March 6, 1948, and April 15, 1951. Photographs, courtesy Audouin Dollfus.



This drawing of Saturn was made on April 23, 1949, by Thomas R. Cave, Jr., using the Griffith Observatory's 12-inch refractor. Exceptionally fine seeing allowed powers of 550 and 833 to be employed. The amount of detail shown is most unusual; there are six ring divisions and much structure in the belts. The dusky south polar region (at the top), the shadow of the planet on the rings, and the Terby white spot just to the right of this are all depicted. The photograph of the drawing is by courtesy of Mr. Cave.

on the globe of Saturn. The seeing that evening approached perfection. Other minor divisions detected with very large telescopes are well beyond the amateur's range.

As for the colors that the amateur may be able to observe on Saturn, aside from the usual light yellowish tone of the planet there will be brighter areas, usually the equatorial zone and the outer portion of ring B. The major dark belts on the globe may sometimes be seen as reddish brown, while the polar areas may show traces of green. The rings, usually gray, have at times been reported as definitely bluish, while the crape ring has sometimes been described as reddish or bluish. All these colors are, generally, much less conspicuous than the colors exhibited by Jupiter.

D. P. AVIGLIANO
2600 E. Orange Grove Ave.
Pasadena 8, Calif.

REPORTS ON THE OCCULTATION BY PALLAS

SEVERAL reports have been received concerning the near passage and occultation of the star BD +5°2171 by the asteroid Pallas on April 7th, discussed by Gordon E. Taylor, H. M. Nautical Almanac Office, on page 172 of the March issue.

Chicago, Ill. Joseph A. Anderer, with powers up to 200x on a 6-inch reflector, clear skies and very good seeing, saw Pallas pass two seconds of arc east of the star at about 8:31 p.m. CST. There was no occultation at Chicago.

Panama City, Fla. N. K. McKinnon saw the asteroid pass north and west of the star, the closest approach being at the northwest point and amounting to about two fifths the separation of the two closest stars in the Trapezium of Orion. The observing position was longitude 85° 39′ west, latitude 30° 9′ north.

Rochester, N. Y. Paul W. Stevens reports that members of the Rochester astronomy group, observing from various points in the area, found the asteroid to pass west of the star. One estimate was about six seconds of arc minimum separation, another three seconds. With a 3-inch refractor, Mr. Stevens was very conscious of elongation but could not say definitely that he saw two points at conjunction.

Gas City, Ind. With an Argus camera attached to his 6-inch Newtonian telescope, John M. Spooner took a series of photographs of the star and the asteroid. Although the minimum separation was not photographed, careful measurement of the negatives indicates a minimum separation of two seconds of arc at 2:31.2 UT, with Pallas passing east of the star.

AURORA IN APRIL

A rather spectacular auroral display on the night of April 11th, observed from Lorain, Ohio, is reported by Louis Rick, secretary of the Black River Astronomical Society. It was first seen at about 10 p.m. EST as a bright, unchanging blue-green solid arc directly to the north, through which 2nd-magnitude stars were visible, extending from the horizon to about 35 degrees, with the ends of the arc within about 20 degrees of the east and west points.

Very abruptly at 10:12 the display changed to a myriad of pulsating rays starting 20 degrees above the horizon at the north point and shooting to heights of about 50 degrees. By 10:30 the display had gradually faded to an indistinct glow, with an occasional ray still visible. Ten minutes later the display ceased.

John R. Anderson, of Fairborn, Ohio, near Dayton, first observed auroral light to the north at about 8:30 EST, which changed from white to a greenish color. Rays radiating from the north were seen, and also horizontal bands.

NOTICE FROM THE AMERICAN METEOR SOCIETY

May I take this means of correcting misunderstandings that have arisen as to the American Meteor Society. First, charts, forms, and the like are **not** distributed to anyone except members of the society; they are not for sale. Second, persons are no longer admitted to membership until they have proved, by submitted observations of meteors, that probably they will be active in its work.

C. P. OLIVIER
American Meteor Society
Flower Observatory
Upper Darby, Pa.

PREDICTIONS OF BRIGHT MINOR PLANET POSITIONS

Parthenope, 11, 8.7. June 7, 18:40.3 —18-22; 17, 18:32.4 —18-41; 27, 18:22.9 —19-06. July 7, 18:13.2 —19-35; 17, 18:04.6 —20-06; 27, 17:58.3 —20-38.

Aquitania, 387, 9.3. June 7, 18:48.7 —2-25; 17, 18:42.7 —3-24; 27, 18:34.9 —4-56. July 7, 18:26.5 —6-54; 17, 18:18.8 —9-11; 27, 18:13.2 —11-39.

Lutetia, 21, 9.2. June 17, 19:32.4 —23-31; 27, 19:25.4 —24-10. July 7, 19:16.3 —24-49; 17, 19:06.5 —25-24; 27, 18:57.5 —25-52. Aug. 6, 18:50.8 —26-10.

After the asteroid's name are its number and the magnitude expected at opposition. At 10-day intervals are given its right ascension and declination (1954.0) for 0^h Universal time. In each case the motion of the asteroid is retrograde. Data are supplied by the IAU Minor Planet Center at the University of Cincinnati Observatory.

OCCULTATION PREDICTIONS

June 14-15 **Sigma Scorpii** 3.1, 16:18.4 —25-29.0, 14, Em: **A** 1:11.0 —1.8 +1.4 256; **B** 1:13.1 —1.6 +1.3 261; **C** 0:55.3 —2.2 +2.3 239.

July 19-20 **Kappa Piscium** 4.9, 23:24.6 +1-00.2, 20, Em: **E** 9:52.3 —2.3 0.0 267; **F** 9:32.2 —2.4 +0.7 258.

For stations in the United States and Canada, usually for stars of magnitude 5.0 or brighter, data from the **American Ephemeris** and the **British Nautical Almanac** are given here, as follows: evening-morning date, star name, magnitude, right ascension in hours and minutes, declination in degrees and minutes, moon's age in days, immersion or emersion; standard station designation, UT, **a** and **b** quantities in minutes, position angle on the moon's limb; the same data for each standard station westward.

The **a** and **b** quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude, respectively, enabling computation of fairly accurate times for one's local station (long. **Lo**, lat. **L**) within 200 or 300 miles of a standard station (long. **LoS**, lat. **LS**). Multiply **a** by the difference in longitude (**Lo — LoS**), and multiply **b** by the difference in latitude (**L — LS**), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Universal time to your standard time.

Longitudes and latitudes of standard stations are:

A +72°.5, +42°.5 **E** +91°.0, +40°.0
B +73°.6, +45°.5 **F** +98°.0, +31°.0
C +77°.1, +38°.9 **G** Discontinued
D +79°.4, +43°.7 **H** +120°.0, +36°.0
I +123°.1, +49°.5

SUNSPOT NUMBERS

March 1, 10, 8; **2,** 8, 11; **3,** 9, 9; **4,** 1, 7; **5-11,** 0, 0; **12,** 8, 8; **13,** 19, 17; **14,** 24, 22; **15,** 26, 36; **16,** 26, 40; **17,** 24, 42; **18,** 26, 39; **19,** 19, 29; **20,** 17, 23; **21,** 15, 17; **22,** 10, 12; **23,** 0, 7; **24,** 5, 7; **25,** 1, 0; **26-31,** 0, 0. Means for March: 8.0 American; 10.8 Zurich.

Daily values of the observed mean relative sunspot numbers are given above. American numbers are computed by D. W. Rosebrugh from AAVSO Solar Division observations; Zurich numbers are from Zurich Observatory and its stations in Locarno and Arosa.

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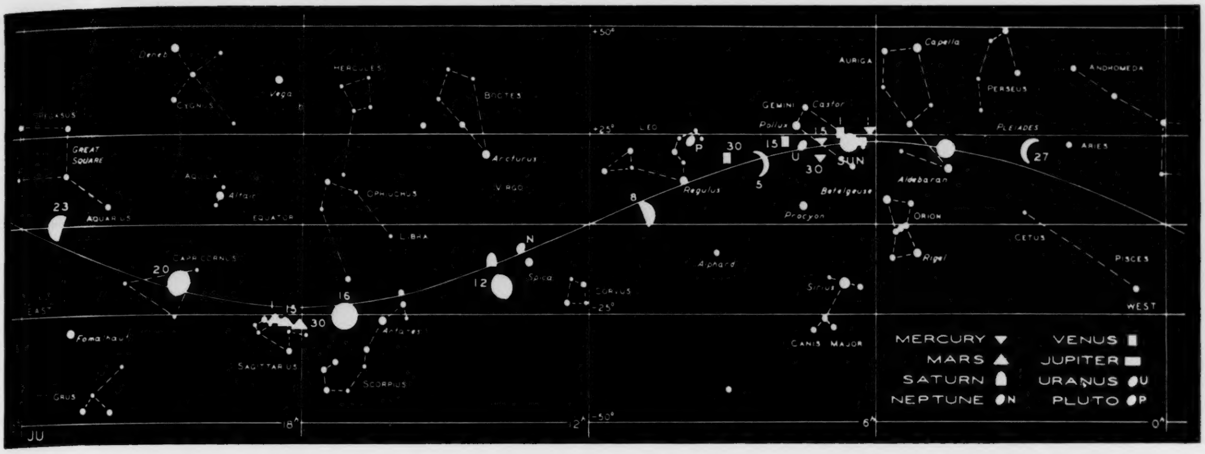

THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month and for other dates shown.

The sun will be totally eclipsed on June 30th. The predicted times of beginning and end of the partial phases at places in the United States are listed on page 263 of this issue.

Mercury will be favorably situated in the western sky during the first half of the month. Greatest elongation occurs on June 9th, when the planet, at magnitude +0.7, will be 24° 01′ east of the sun. In the evening twilight of June 2nd, Mercury, Jupiter, and the crescent moon will form an interesting triangle very low in the western sky, with Venus not far to the east.

Venus, visible for 2¼ hours after sunset in the western sky, far outshines any star or other planet. Appearing at magnitude −3.4, the planet travels eastward through Gemini and Cancer in June. On the evening of the 22nd, Venus crosses the northern part of the Beehive cluster in Cancer.

Earth arrives at heliocentric longitude 270° on June 21st at 22:55 UT, when summer begins in the Northern Hemisphere, and winter in the Southern.

Mars, in Sagittarius, is conspicuous by its ruddy brilliance in the southern midnight sky. Opposition occurs June 24th, when the planet is 40,180,000 miles from the earth; at closest approach, on July 2nd, it will be 410,000 miles nearer. Unfortunately for northern observers, the planet is at −28° declination and only 22° above the horizon at midnight as seen from latitude 40° north. The Martian disk is 21″.6 in diameter on the 24th, easily discernible in a small telescope. For further details, see the article on page 265.

Jupiter may be glimpsed very low in the western sky in early June, setting one hour after sunset on the 10th. Conjunction with the sun occurs on June 30th, and the planet will be behind the sun during the total eclipse.

Saturn will be on the meridian at sunset in late June, a +0.7-magnitude object. It is moving westward in Virgo. The ring system is inclined 16°.7 to our view. At mid-month its longest diameter is 41″, and Saturn's polar diameter is 16″.

Uranus becomes lost in the sun's glare during the month. On the 10th, Venus will be 1° 23′ north of Uranus at 4^h UT.

Neptune can be located until midnight in the western sky in Virgo, with the aid of the chart on page 137 of the February issue.

During the first 10 days of June, all the planets may be seen during the two-hour period after sunset, with the moon as well from the 3rd on. All will be visible at one time except for Mars, which rises soon after Jupiter sets. From west to east, the array will be Jupiter, Mercury, Venus, Uranus, Pluto (visible only in large telescopes), Neptune, Saturn, and Mars.

E. O.

MINIMA OF ALGOL

June 1, 6:48; 4, 3:36; 7, 0:25; 9, 21:14; 12, 18:03; 15, 14:52; 18, 11:41; 21, 8:29; 24, 5:18; 27, 2:07; 29, 22:55. July 2, 19:44; 5, 16:32; 8, 13:21.

These minima predictions for Algol are based on the formula in the 1953 **International Supplement** of the Cracow Observatory. The times given are geocentric: they can be compared directly with observations.

MOON PHASES AND DISTANCE

New moon	June 1,	4:03
First quarter	June 8,	9:13
Full moon	June 16,	12:06
Last quarter	June 23,	19:46
New moon	June 30,	12:26
First quarter	July 8,	1:33

June			Distance	Diameter
Apogee	11,	15^h	251,800 mi.	29′ 30″
Perigee	27,	10^h	227,300 mi.	32′ 40″
July				
Apogee	9,	8^h	251,200 mi.	29′ 33″

UNIVERSAL TIME (UT)

TIMES used on the Observer's Page are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the UT before subtracting, and the result is your standard time on the day preceding the Greenwich date shown.

VARIABLE STAR MAXIMA

June 7, RU Cygni, 213753, 8.0; 9, R Ophiuchi, 1702**15**, 7.6; 10, S Pictoris, 0508**48**, 8.0; 14, RT Cygni, 194048, 7.4; 15, R Bootis, 143227, 7.3; 15, RS Librae, 1518**22**, 7.7; 16, T Centauri, 1336**33**, 6.1; 16, T Herculis, 180531, 8.0; 16, V Cassiopeiae, 230759, 7.9; 16, R Phoenicis, 2351**50**, 7.8; 22, V Monocerotis, 0617**02**, 7.1; 23, S Coronae Borealis, 151731, 7.5; 26, RU Sagittarii, 1951**42**, 7.2. July 1, Z Puppis, 0728**20**b, 7.9; 1, R Virginis, 123307, 6.9; 4, T Columbae, 0515**33**, 7.6; 4, S Virginis, 1327**06**, 7.1.

These predictions of variable star maxima are by the AAVSO. Only stars are included whose mean maximum magnitudes are brighter than magnitude 8.0. Some, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern), and the predicted magnitude.

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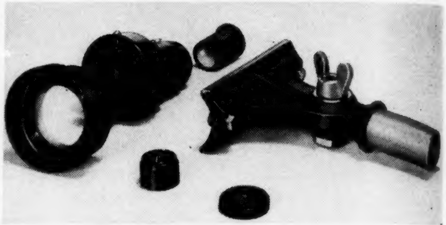

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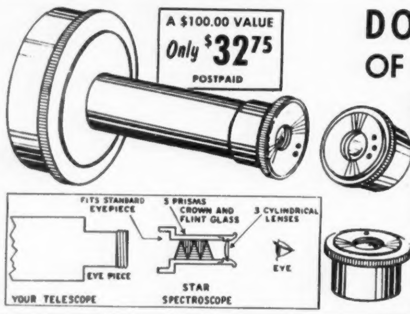

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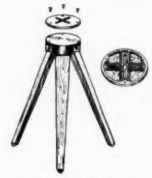

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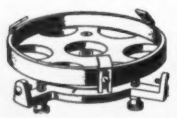

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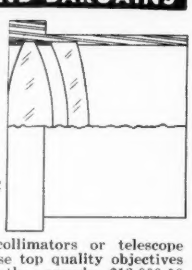

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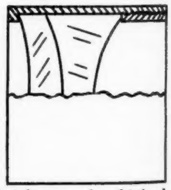
MOUNTED BARLOW LENS Short Focal Length



E.F.L.: —1.74 ± 0.01 inches
CLEAR APERTURE: 0.96"
O.D. OF CELL: 1-3/16"

A negative achromat called a Barlow lens is used to convert your astronomical objective — lens or mirror — into a telephoto system. Thus a variable-power astronomical telescope is obtained. The great advantage of this system is that higher powers may be obtained without resorting to very short focal length eyepieces or very long and cumbersome telescopes.
Our Barlow lens is well made, finely corrected so that no image deterioration is sustained. Short focal length allows the lens to be used closer to the primary focus, thus making it convenient to use as part of the eyepiece system. Short focal length also insures that the total length of the telescope will not be increased an impracticable amount.
Direction sheets on the use and the mounting of the Barlow lens are available.
Stock #30,140-Y .... $15.00 Postpaid

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If you haven't seen our big, FREE Catalog, you don't know what you're missing. Fantastic variety — never before have so many lenses, prisms, optical instruments, and components been offered from one source. Positively the greatest assembly of bargains in all America. Imported! War Surplus! Dozens of other hard-to-get optical items. Write today for FREE CATALOG "Y".

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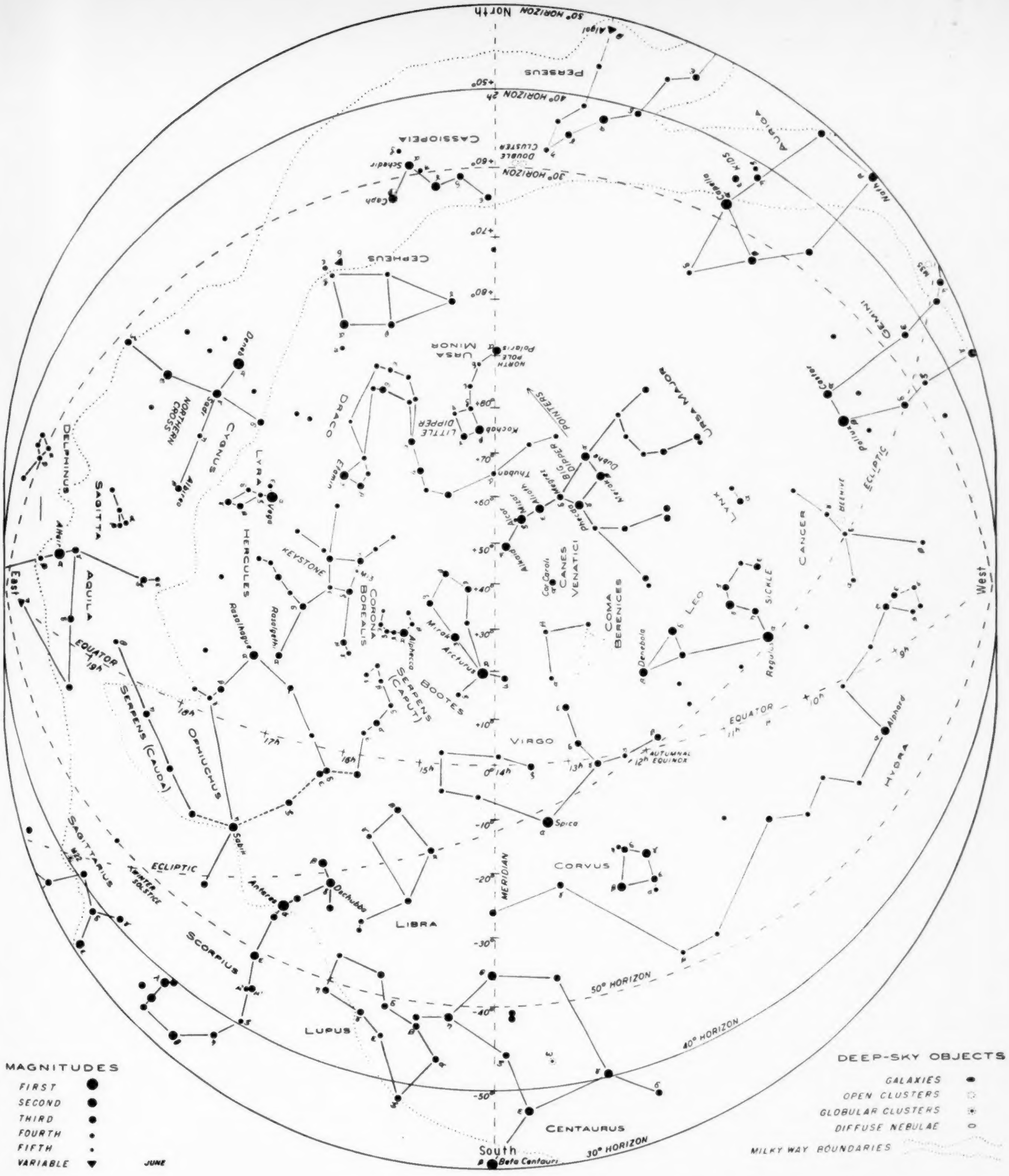

The sky as seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of June, respectively.

STARS FOR JUNE

JUNE twilight lasts long, well past our chart times in the more northerly parts of the United States. By the time darkness has become complete, the great constellation of Hercules, the kneeling giant, has moved to the zenith, where it dominates the sky.

The reddish 3rd-magnitude star Alpha Herculis, or Rasalgethi, is of special interest. It is one of the largest stars known, a vast tenuous globe of rarefied gas. Sir William Herschel found more than a century and a half ago that it is a variable star. The light changes seldom exceed half a magnitude, and follow no regular pattern. The naked-eye observer who compares the brightness of Rasalgethi with that of other stars in the vicinity can trace its capricious changes for himself from week to week.

In a small telescope, Rasalgethi is resolved into a beautiful double star whose 5th-magnitude blue companion, about five seconds of arc distant, provides a striking color contrast with the reddish primary star.

The great globular cluster, M13, lying along the western side of the Keystone in Hercules, is well worth the trouble of finding. On a clear, moonless night it can be picked up without optical aid, looking like a 6th-magnitude star, one third of the way from Eta to Zeta Herculis. In a small telescope it is a nebulous patch, but a large instrument shows it to be a great swarm of stars, closely packed toward the center.

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UNITRON Model 155 set up for observing.

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for visual observation and astro-photography

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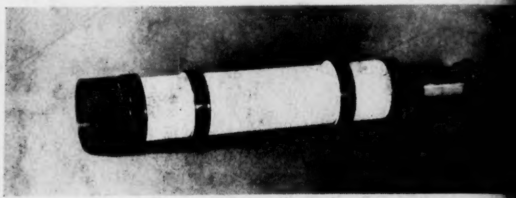
This enviable reputation has been built by the outstanding quality and value of the instruments themselves — their superior performance, precision workmanship, and modern design.

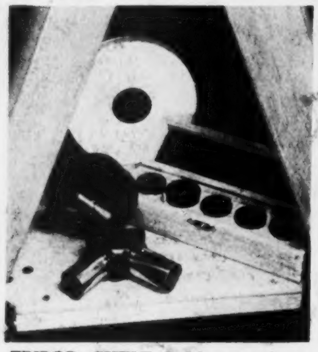
MODEL 155 COMPLETE as illustrated with equatorial mounting and tripod, 2.4" photographic guide telescope with star diagonal and crosshair eyepiece, 10x, 42-mm. view finder, 6 eyepieces, sun projecting screen, sunglass, solar aperture diaphragm, star diagonal, erecting prism system, dewcap, dustcap, pocket eyepiece case, wooden cabinets, etc. **Only $890**

MODEL 152 as above but without guide telescope **Only $78**

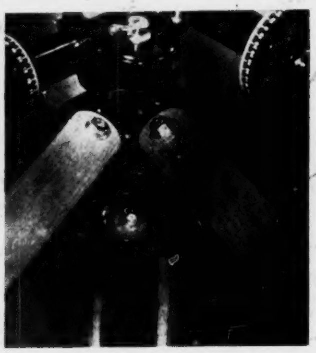
An ASTRO-CAMERA and CLOCK DRIVE are in the final design stage and will be available shortly as separate accessories. A FIXED METAL PIER will be offered for permanent installation.



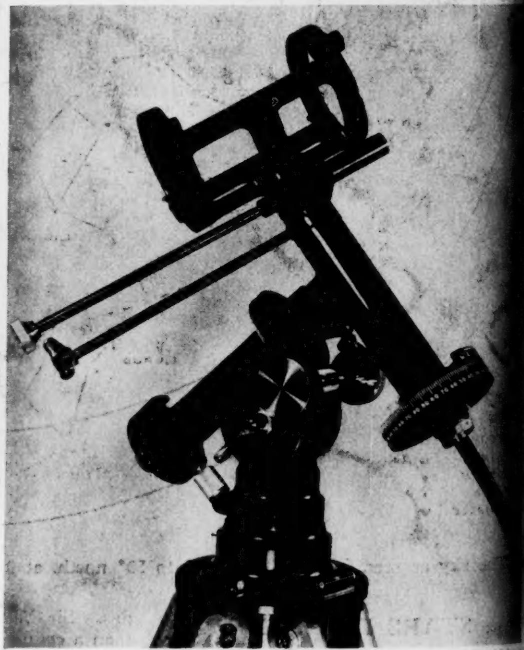
Large 10x, 42-mm. (1.6") VIEW FINDER.



TRIPOD SHELF holds eyepieces and accessories while observing.



Battery-operated LAMP casts a reddish light on the shelf.



EQUATORIAL MOUNTING with micrometric slow motion controls for both R. A. and declination, setting circles and verniers, and latitude adjustment.

Many of the components of UNITRON 4" Refractors are available separately — see our advertisement on page 278.

Use our time payment or lay-a-way plans to obtain a large telescope right from the start! No red tape — application form available on request. And if you haven't already received a copy of our free catalog, we should be happy to rush one to you. A special section tells you how to choose a telescope. All instruments fully guaranteed. Shipment via express collect. Send check or money order or 25% deposit with balance C.O.D. Write to Dept. TC-6.

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